The Welding Engineer

Edited by L. B. Mackenzie

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Air Reduction Sales Co.
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Imperial Brass Mfg. Co.
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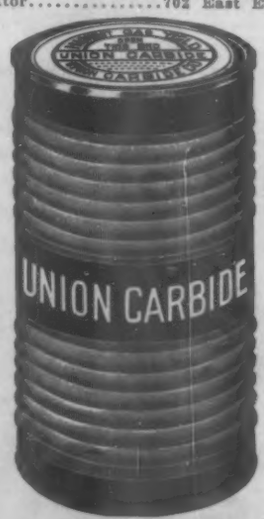

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Made from a distinctive wrought iron of great purity and possessing unique welding qualities. Furnished in different grades for Gas or Electric Arc Welding, in coils and cut to length, and in Bare Finish, Coppered or Flux Coated.

Full particulars, prices and samples on request.

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International Oxygen Co.
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General Electric Co.
Lincoln Elec. Co.
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Carbic Mfg. Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Metals Welding Co.
Transportation Engineering Corp.

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Burdett Oxygen Co.
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Metals Welding Co.
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Transportation Engineering Corp.

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Transportation Engineering Corp.
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C. Sorensen.

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ALPHABETICAL INDEX TO ADVERTISERS

Air Reduction Sales Co. ..... Front Cover
Albert Lea Foundry Co. 47
American Carbolite Sales Co. ..... Back Cover
Atlas Foundry Co. 43

B

Bastian-Blessing Co., The. .....
Bierman-Everett Fdy. Co. 50
The Buckeye Welding & Sup. Co. 50
Buffalo Dental Mfg. Co. 13
Burdett Mfg. Co. 16

C

Carbic Mfg. Co. 51
Central Steel & Wire Co. 42
Chicago Eye Shield Co. 49
Chicago Steel & Wire Co. 3
Commercial Acetylene Supply Co. 9
Compressed Gas Corporation. 3
Wm. Cramp & Sons. 12

D

M. Keith Dunham. 47

E

Electric Arc Welding & Cutting Co. 50
Everstay Sales Co. 48

F

F. D. Farnam & Co. 43
Federal Brass Works. 13

G

Gas Tank Recharging Co. 16
General Electric Co. 33
Gas Products Assn. 15

H

Hauck Manufacturing Co. 10

I

Imperial Brass Mfg. Co. 50
International Oxygen Co. .....

K

K-G Welding & Cutting Co. 43

L

Linde Air Products Co. 18
Lincoln Electric Co. 11
L. Lawrence & Co. 10

M

Manganese Steel Forge Co. 49
Metals Welding Co. 14
Morey Flux & Chemical Co. 50
Modern Engineering Co. 13
Thomas B. Morris Co. 48

N

National Carbon Co. 50

O

Oxweld Acetylene Co. 2

P

Page Steel & Wire Co. 39
The Prest-O-Lite Co., Inc. 31

Q

Quasi-Arc Weldtrode Co. 50

R

Reid-Avery Co. 45
Rochester Welding Works. 4
Roebling, John A., Sons Co. 14

S

Sali Mountain Co. 47
C. Sorensen 50
Superior Oxy-Acetylene Machine Co. 49
Southern Welding Machine Co. 6
Shawinigan Products Corporation. 12
Smith's Inventions, Inc. 10
Standard Carbide Sales Co., Inc. 14
N. A. Strand & Co. 50
Swift & Co. 5

T

Torchweld Equipment Co. 45
Transportation Engineering Corp. 13

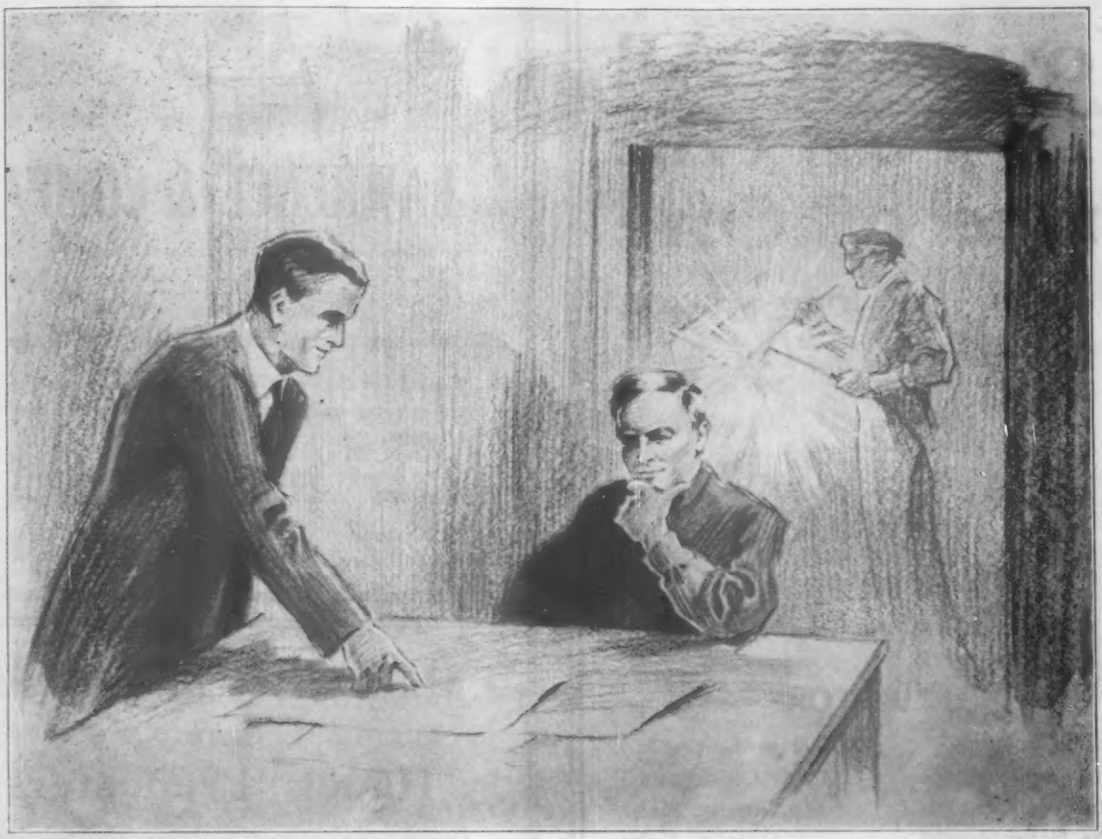
U

Union Carbide Sales Co. 7
U. S. Gauge Co. 48
United States Welding Co. 49

W

Westinghouse Elec. Mfg. Co. 17
Wm. Wharton, Jr., & Co., Inc. 50
Wilson Welder & Metals Co. 47
Wodack Electric Tool Corporation. 48

The welder wants the best gas and the buyer wants the best price. The COMMERCIAL salesman points out the way to please both. It's the COMMERCIAL way. Investigate.



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Do you understand our acetylene sales plan and are you acquainted with our prices?

We can supply you as pure acetylene as can be produced; sell you at a reasonable figure and give a broad, liberal cylinder loan not requiring an investment by you. It is a pleasure for us to quote prices and explain our free loan plan of cylinders. All we ask is an outline of your consumption.

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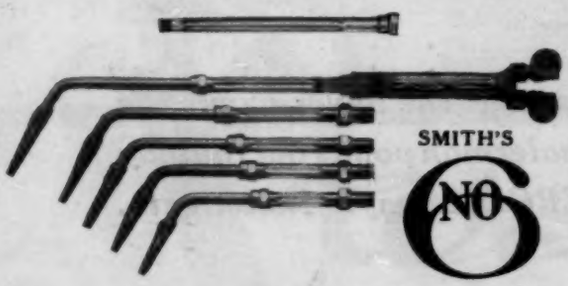

You Get All Six for the Price of One

Made to give long service
It's the 100% Torch
Write for Facts

Address Department B

Exclusive Manufacturers of

SMITH'S INVENTIONS INCORPORATED

Welding and Cutting Equipment

Minneapolis, Minn.

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Campbell Iron Co.....St. Louis, Mo.
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Motor Mercantile Co.....Salt Lake City, Utah
Seattle Oxygen Co.....Seattle, Wash.
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Over 500 Licensee Representations Throughout the World.

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Originators of Lawrence Scored Cylinder Process
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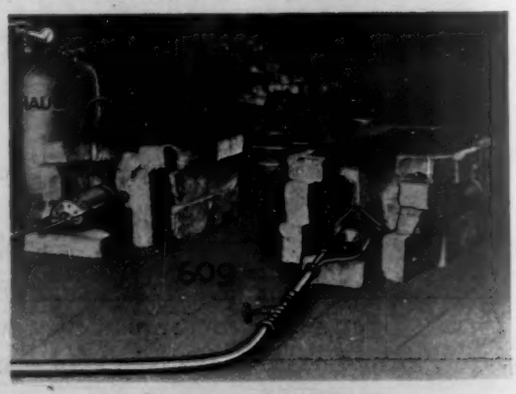
Repairs to Scored Cylinders by Lawrence Patented Process are permanent and guaranteed for the life of the motor.

Shop licenses obtainable. Write for particulars and prices today, as someone may be ahead of you.

Distibutors of De Luxe Light Weight Gray Iron Pistons, Rebco and Hi-Speed Rings and Wrist Pins.

Make Better Profits *with* Hauck Preheaters



Preheating furnace heater section cracked along the corner of each leg and through the center with Hauck Double Preheater No. 8.

The owner of one of these preheaters writes:
"It has not only proven eminently satisfactory for preheating but it has also materially reduced both the gas consumption and the time required for welding."

Write for booklet No. 127

Hauck Manufacturing Co.

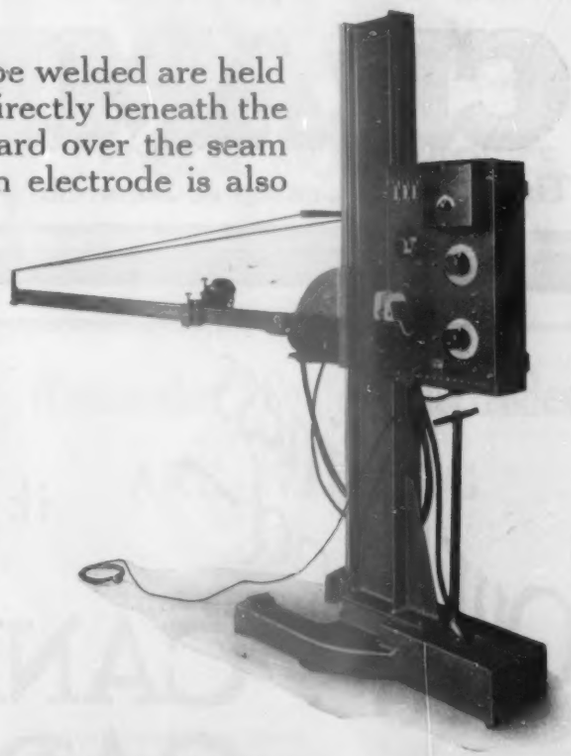
Established 1900
122 Tenth Street, Brooklyn, New York

LINCOLN ARC WELDER

A "Sewing Machine" for Steel

THAT is what someone has called the Lincoln **Automatic** Arc Welder—the latest contribution of Lincoln Engineers to the science of welding.

In this machine the pieces to be welded are held in a clamp or special fixture directly beneath the arc. The arc is moved forward over the seam automatically and the carbon electrode is also fed down automatically, making a speedy uniform welding job at very low cost.



The welding operator can greatly increase both the quality and amount of his work with the Lincoln Automatic Welder. It will open up vast new fields for the man who knows welding.

Write for Information on this Lincoln machine.

The Lincoln Electric Co.

General Offices and Factory
Cleveland, Ohio

The Lincoln Electric Company of Canada, Ltd., Toronto—Montreal

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Buffalo
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Chicago
Detroit
Columbus
Pittsburgh
Philadelphia
Boston
Charlotte, N. C.
Minneapolis
London, England

Agencies in other Principal Cities

This Standard Lincoln Motor operated over 3 years under water without damage.

WELDING RODS

Parsons' Manganese Bronze Rolled Welding Rods

the Strongest Bronze Made

for high-fire Brazing and Oxy-Acetylene Welding of Malleable Iron or Bronze and Brass castings assure a faultless, flawless job. This is another example of the "Cramp" standard of quality. This scientifically perfected metal is the result of long years of experience. Its fine physical properties make it especially suitable for welding purposes.

A strong weld of fine close grain and exceedingly tough texture is always the result where Cramp's Welding Rods are usesd.

We can also furnish Welding Rods of Cramp's Cast Iron, Cramp's Copper Covered Iron, Cramp's Vanadium Steel, Cramp's Drawn Aluminum, Cramp's Cast Aluminum, Cramp's American Iron and Soft Brass Brazing Wire.

CRAMP

We furnish and will be glad to estimate on all kinds of brass and bronze castings.

The William Cramp & Sons Ship & Engine Building Co., Philadelphia

Our business is Good— it ought to be—

CANADIAN CARBIDE is Good Carbide

SHAWINIGAN PRODUCTS CORPORATION 110 WILLIAM ST. NEW YORK

SHAWINIGAN

No. 8-G for Natural Gas, $8.00

LOOK

The two most essential points in welding are:

FIRST: The use of a proper sized oxy-acetylene flame.

SECOND: The saving of gas by preheating your work for the oxy-acetylene flame.

The first is under your control in the use of the oxy-acetylene apparatus you have selected.

The second, we can aid you in by supplying the proper blowpipe for preheating purposes.

We manufacture blowpipes for use with Coal Gas, Natural Gas, Gasoline Gas and Acetylene Gas, with Air Blast.

Our catalog "B. X." free for the asking. contains full description and prices. WANT ONE?

Buffalo Dental Manufacturing Co.
Buffalo, N. Y., U. S. A.

Federal Regulators
Help SELL Your Torches

100% Efficient
Cheapest in the End

Improve Your Torches By Using "Federal" Regulators

"Ask for Catalog"

FEDERAL BRASS WORKS
3100 SOUTH KEDZIE AVENUE, CHICAGO

MECO MULTI-SEAT REGULATORS have four seats instead of one, but cost no more.

Write for prices and start to reduce your costs — NOW.

Modern Engineering Company
3411 Pine Street - - - St. Louis, U. S. A.

Wanamaker Coated Electrodes
FOR
ARC WELDING

COATED WANAMAKER ELECTRODES

Reduce your labor costs.
Reduce your current costs.
Reduce your electrode material costs.

Increase your production.
Increase the operators' efficiency.
Increase the quality of your welds.

Write for details.

The new Tecor Specialties Bulletin describes the WANAMAKER COATED ELECTRODES, also a complete line of welding accessories.

Write for it today.

Transportation Engineering Corporation
15 PARK ROW, NEW YORK CITY.
608 SOUTH DEARBORN ST., CHICAGO, ILL.

"The Right Carbide For the Right Job"

Smiling Dave O'Kay
(EXPERT CUTTER AND WELDER)

"I'VE been in the trade over twelve years—but it was only since *Standard Carbide* went on the market that I know what a 100% A1 real job is.

"At first the boss sent me out on the toughest jobs, or wherever good, fast work was needed. You see—he thought I had it over the rest of the cutters and welders for speed and good work;—but it wasn't me it was the Standard Carbide, and when the crowd got on to that, they all used it—and we were the best and fastest working bunch you ever want to see.

"Believe me you can't go wrong with 'Standard.' It's got it on everything else, for the hottest flame and the purest raw materials. A hundred pound moisture-proof, blue steel drum of 'Standard' contains 100 pounds of pure carbide—and nothing else.

Smiling Dave O'Kay
(EXPERT CUTTER AND WELDER)

Standard Carbide produces a steady, even flow of pure acetylene There are no impurities to clog the generator and cause the flame to flicker or die at the critical moment. It lasts longer and costs no more than ordinary carbides, which really makes it cost less than other kinds. It is by far the most popular among expert welders and cutters.

STANDARD
CARBIDE
Burns Brighter—Lasts Longer

Standard Carbide Sales Co., Inc.
Main Office : : 15 West 37th St., New York

Roebling Welding Wire

Conforming to Spec. E1B and G1A of The American Welding Society

ROEBLING ELECTRODES
Absolutely uniform in quality

Roebling Wire Electrodes are supplied in the following standard sizes: ¼-in.; 5/32-in.; 3/16-in.; ⅛-in.; 5/32-in.; 3/16-in.; 7/32-in., having a standard length of 14-in., in bundles 50 lbs. each, and are always available for quick shipment. Sizes other than the above and as large in diameter as ½-in., having any length required, either straightened or in coils can be furnished on order. Roebling Electrodes give maximum penetration and maximum strength of welds.

ROEBLING GAS WELDING STICKS
99.75% Pure Iron

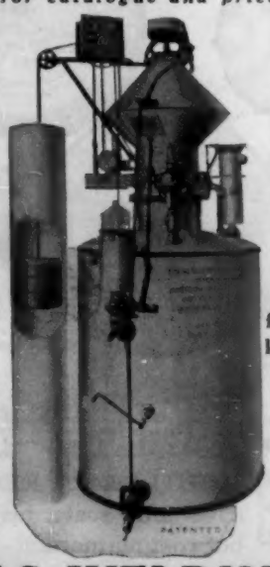
Roebling Wire Gas Welding Sticks are copper coated to distinguish them easily from Roebling Electrodes. They are supplied in standard sizes: 1/16-in.; 5/64-in.; ⅛-in.; 3/16-in.; ¼-in.; 5/16-in.; 3/8-in.; 7/16-in.; and in standard lengths of 36 in. in bundles weighing 50 lbs. each, well protected by weatherproof paper or burlap. Sizes other than the above either straightened or in coils can be furnished on order.

JOHN A. ROEBLING'S SONS CO.
TRENTON, N. J.

LET MET WELD GENERATOR EARN YOU MONEY

Write for catalogue and price list

Distributors of
Milburn Welding & Cutting Equipments
for
Ohio—Penna. Mich.—New York



Write for our **Monthly Price List**
Metweld Welding Rods
for welding all kinds of metal

METALS WELDING CO.
Welding Supplies of Every Nature
4400 Perkins Ave., Cleveland, O.
Long Distance Phone—Randolph 2836
Buffalo, N. Y. BRANCHES Detroit, Mich.

Wherever you are located, or whatever your requirements, you can be supplied promptly with the purest oxygen and hydrogen by any of the plants listed below. They are well located in the United States and Canada, with the object in view of adequately meeting the needs of oxygen and hydrogen users throughout the country.

Our chain of plants, spanning the continent, enables us to supply those industries having several factories, as wherever your factory may be located there is one of our plants within shipping distance.

An inquiry directed to the nearest plant listed below will bring you information promptly regarding sales and service plans. Also, if you wish it, advice and co-operation pertaining to any matter involving the use of oxygen and hydrogen.

CALIFORNIA
California Compressed Gas Co., Los Angeles
California Compressed Gas Co., Oakland
COLORADO
Colorado Compressed Gas Co., Denver
GEORGIA
Standard Gas Products Co., Atlanta
ILLINOIS
Acme Oxygen Co., Chicago
Burdett Oxygen & Hydrogen Co., Chicago
Electrox Co., Peoria
National Oxygen Co., Chicago
Swift & Co., Chicago
INDIANA
Indiana Oxygen Co., Indianapolis
Logansport Oxygen Co., Logansport
IOWA
Bettendorf Oxygen Hydrogen Co., Bettendorf
KENTUCKY
Kentucky Oxygen and Hydrogen Co., Louisville
LOUISIANA
Louisiana Oxygen Co., Inc., New Orleans
MANITOBA
Auto-Lite Gas Co., Ltd., Winnipeg
MICHIGAN
Burdett Oxygen Co. of Detroit, Detroit
Michigan Ox-Hydric Co., Muskegon
National Oxygen & Machinery Co., Detroit
MINNESOTA
Commercial Gas Co., Minneapolis
MISSOURI
Kansas City Oxygen Gas Co., Kansas City (two plants in Kansas City)
St. Louis Oxygen Co., St. Louis
MONTANA
Mountaineer Welders' Supply Co., Butte
NEBRASKA
The Baibach Co., Omaha
OHIO
Clarke Chemical Co., Wickliffe
Ohio Electrolyte Oxygen Co., Cincinnati
OKLAHOMA
Burdett Oxygen Co. of Oklahoma, Oklahoma City
Tulsa Oxy-Hydro Co., Tulsa
OREGON
Portland Oxygen & Hydrogen Co., Portland
PENNSYLVANIA
Burdett Oxygen Co., Philadelphia (plants at Chester and Norristown)
Burdett Oxygen & Hydrogen Co., Pittsburgh, Pa.
National Oxygen Co., Erie
TENNESSEE
Burdett Oxygen Co., Chattanooga
Memphis Oxygen Co., Memphis
TEXAS
Burdett Oxygen Co. of Texas, Fort Worth
Magnolia Gas Products Co., Houston
UTAH
Utah Compressed Gas Co., Salt Lake City
WASHINGTON
Washington Compressed Gas Co., Seattle
WISCONSIN
Universal Oxygen Co., Sheboygan
Wisconsin Oxygen & Hydrogen Co., Kenosha

Gas Products Association

140 So. Dearborn St. -:- CHICAGO, ILL.

The Gas Business Is Good

Burdett Valves Help Keep It Good

Capacity production is the rule again in the gas industry. Old accounts come to life and new accounts pop up unexpectedly. It's time to check all old cylinders for serviceability and stock new cylinders. In other words, get ready for a further increase in the demand for gases.

Equip all your cylinders—old and new—with the

Burdett Standard High Pressure Valve

By eliminating gas leaks and valve troubles, this valve PAYS FOR ITSELF in service.

It ought to—it's BUILT FOR SERVICE.

The body itself is SOLID BRONZE. That means long life for the outlet connection threads, a distinct advantage.

The seat is tapered and swivel mounted; made of monel metal; can't twist or wear.

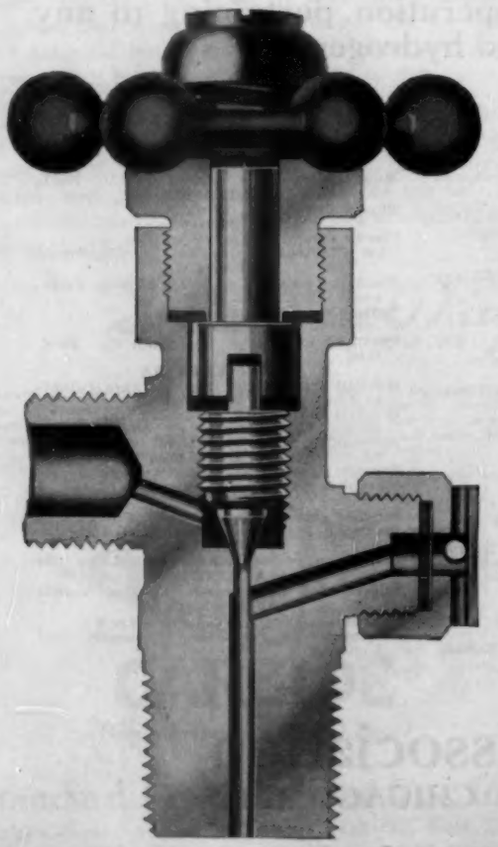
The "plug to stem" construction ADDS FURTHER STURDINESS, and ELIMINATES TROUBLE from twisted valve tongs.

In fact, it is a HIGH GRADE VALVE in every respect; and it has enjoyed tremendous popularity on account of its LOW PRICE.

But the price of this valve has recently been revised—DOWNWARD.

We knew THAT would interest you. Now submit your valve requirements and GET OUR LATEST QUOTATIONS.

BURDETT MANUFACTURING CO.
309 St. John's Ct. Chicago, Ill



SUN-LITE

BRAND

CALCIUM CARBIDE

Is made from best grade of coke and lime. Scientifically treated in an electric furnace so as to produce carbide of excellent quality and large gas yield.

For ACETYLENE GENERATORS

Sizes

3½x2
2x½
1¼x⅜
¼x1/12

Packed in non-returnable steel drums containing 100 lbs. net.

Manufactured by

Gas Tank Recharging Co.

Works: Keokuk, Iowa
General Office: - Milwaukee, Wis.

Distributed by

Big Three Welding & Equipment Co.
Oxy-Acetylene Equipment and Supplies
FORT WORTH
TEXAS

SUN-LITE

After the Showdown

The great "buyers' strike" of 1920-21, a never-to-be-forgotten event in the economic history of this country, proved a point which must henceforth be recognized as basic and incontrovertible.

It was discovered by merchants and jobbers everywhere, in practically every line of merchandise, that it was the trademarked and adequately advertised brands of goods that got the lion's share of the business there was to get, while the preponderant loss of sales fell on the unbranded and unadvertised goods.

This was a great "showdown" for Advertising. Its position as a factor in economic life was on trial. Had it really done what had always been claimed for it? Had it created consumer preference that would hold against the keen competition of a sacrifice price on unmarked goods?

The verdict of the buying public was unqualified. It was not a straw vote to determine popularity. It was the final test of willingness to buy. The ballots were dollars. And the preponderant majority voted with their dollars that they preferred to keep right on buying advertised goods.

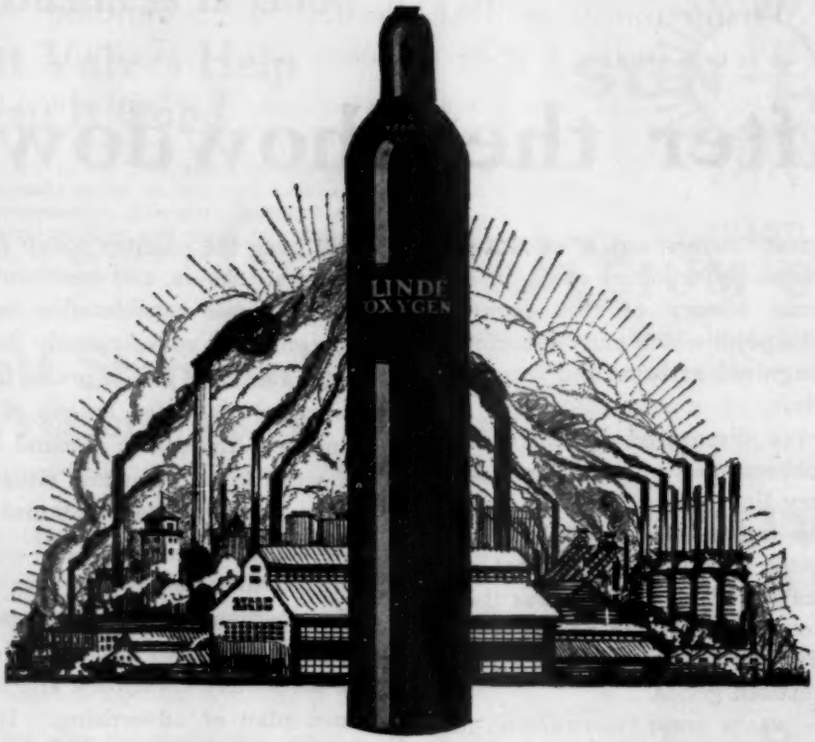
With the whole country on a reduced schedule of production and sales, the factories that were able to keep on producing, in anything like normal quantities, were invariably those making trademarked and nationally advertised goods.

All over the country today manufacturers, jobbers, and merchants are giving serious consideration to this important and conspicuously demonstrated fact: the public prefer to buy nationally advertised brands of merchandise. And public demand is the last word in all economic situations. No one can go against it and long endure.

This will mean, then, that more and more manufacturers will seek out ways to make their products worthy of a distinctive trademark and a sustained plan of advertising. It will mean that merchants will more and more give preference in their stocks to advertised brands. It will mean that the jobbers will more and more arrange to supply the merchant with advertised brands.

But new advertisers, manufacturers who are finally convinced that their future lies in the direction of an advertised product, will discover that the magic power of advertising cannot be applied overnight. It may require sustained effort to attain a position of equality with competitors who have been advertising for many years. This will be an unwelcome discovery. But it will be found to be the truth, and will be their only hope of gaining a substantial foothold in what, from now on, must continue to be a more keenly competitive market than we have known for a generation.

[Published by The Welding Engineer in co-operation with The American Association of Advertising Agencies]

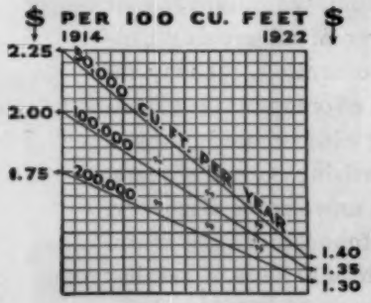


A Policy and Its Results

In 1914 when the oxygen industry was in the early stages of development the LINDE COMPANY adopted as two important features of its sales policy:

First: A definite schedule of prices based on consumption.

Second: A reduction of prices as rapidly as increased volume warranted.



The accompanying chart shows typical prices applying in 1914 as compared with those applying under our new 1922 schedule. This illustrates clearly the benefits to LINDE users of the continued application of these two features to the large increase in production since 1914.

The 1922 prices shown for the respective consumptions are the average for the entire chain of 30 plants and 50 warehouses through which LINDE OXYGEN is distributed today. Slightly lower prices prevail at the plants in districts of heavy oxygen demand. Higher prices prevail where shipments are made from convenient service warehouses, or where undeveloped consumption does not permit large scale plant production and distribution.

No oxygen user, large or small, should close an arrangement for oxygen supply without first securing 1922 prices from the nearest LINDE District Sales Office.

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2281-22

CONTRACTION IN TUBE WELDING

Distortion Can Be Avoided by Expanding Pieces in the Opposite Sense before Welding

By Marcel Piette, in Revue de la Soudure Autogene, Translated with Additions by Capt. D. Richardson

IN the butt welding of parallel or conical tubing, a common distortion noticed after welding is that shown in the upper diagrams of Fig. 1. The circular line of welding becomes shorter after welding thus diminishing the diameter and producing a distinct inflection or groove on each side of the

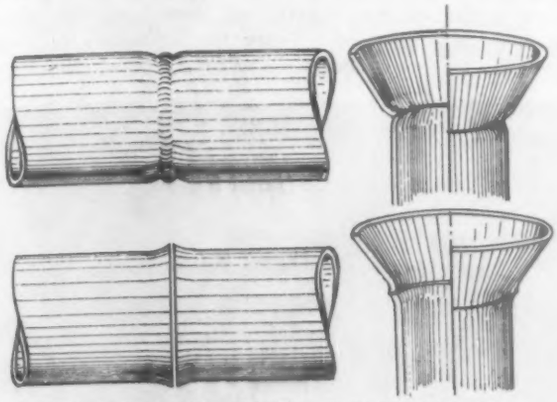


Fig. 1—Contraction Effect in Butt Welded Tubes.

line of welding which gives a very unsatisfactory finish to the joint. The simplest way to eliminate this distortion, which is due to contraction effects, is to expand the ends of the tubes, previous to welding, as shown in the lower diagrams of Fig 1. The amount to which the tube should be expanded, in other words the diminution in diameter due to the welded circumference, can be calculated, or determined from practical results, sufficiently accurately as to produce a diameter at the weld the same as the original diameter of the tube, or, in the case of welding conical tubing without any unsightly inflections.

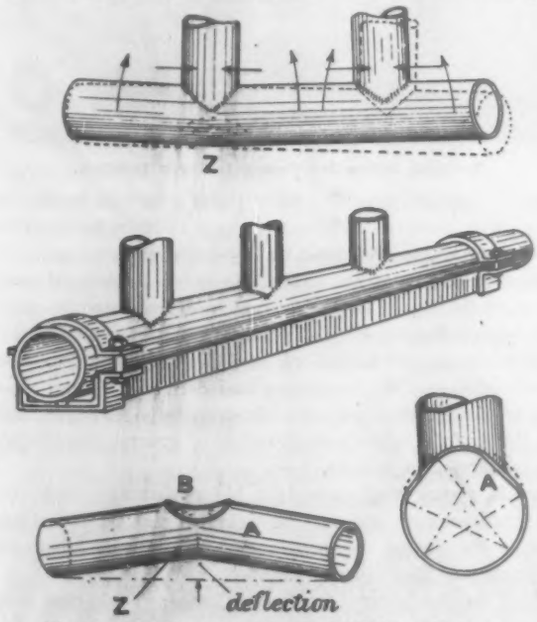


Fig. 2—Avoiding Distortion in T-Welding Tubes.

2. These distortions are due to causes which have already been explained with regard to pipe and tube welding namely, diminution in the length of the line of welding due to contraction and the transverse contraction of the molten bath tending to straighten the plates in the vicinity of the weld.

In the case of thin tubes of small diameter, the tubes can be easily straightened after welding without any disadvantages, but this is not the case when the tubes are thick and of large diameter. In the latter case it is advisable to bend the tube previous to welding, in the vicinity of the weld so as to give it a deflection in the opposite sense to that which the contraction effects tends to produce as shown in Fig. 2 lower diagram.

In the manufacture of welded manifolds, in which the tubes are very close to each other, the curve produced by the contraction of each branch, when added together produce a considerable deflection over the whole length of the manifold. Many workshops avoid, in a very large measure, this deformation by making use of the jig shown in the middle diagram of Fig. 2. This device consists of a channel in which the main tube is placed and clamped solidly in position at either end. With a properly designed channel and the use of packing under the several openings in the tube it is possible to bend the tube slightly in the opposite sense to that produced by the contraction effects. The contraction after welding will be in a different sense to that produced without these precautions and will produce an oval effect in a direction perpendicular to the axis of the tubes, a distortion of less importance than that of the main tube.

The bending of the tubes is usually carried out by raising the parts A and B, Fig. 2, on either side of the orifice, to a red heat.

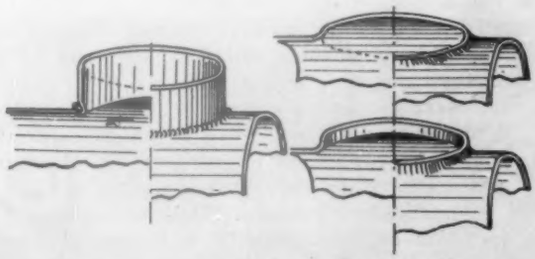


Fig. 3—How the Design Affects Final Shape.

The second distortion in welding manifolds affects the sides and produces a flattening of the tube. This distortion is least important when the difference between the diameters of the main and branch tubes is large and when the thickness of the tube is also large. It is useful to repeat that this distortion is of much less importance than the one previously dealt with.

When welding very large tubes on to tubes or pipes of large diameter, the distortion produced is that shown in Fig. 3, left-hand diagram. It is possible to observe in this case the different effects produced by the contraction of molten baths prepared practically in the same way but made in one case on parts of distinctly different diameters and in the other where the diameters and thickness are relatively small. The contraction effects produced are very similar to those obtained when welding sheets and plates. Two methods of preparation are in use for this class of work, first, deforming or altering the opening of the main tube by the necessary

In constructing manifolds where small branch tubes are welded on to larger tubes or pipes there are two common distortions. The most important is the longitudinal distortion or deflection of the larger tube, the other being the circumferential distortion; these distortions are shown in Fig. amount and seondly, by altering the direction of the con-

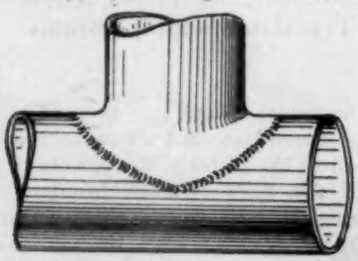


Fig. 4—Good Results From This Design Are Difficult.

traction effects by welding the branch tube on to a flanged opening, Fig. 3.

In many sheet metal workshops the welding of branch pipes on to large pipes is often carried out on the prepar-

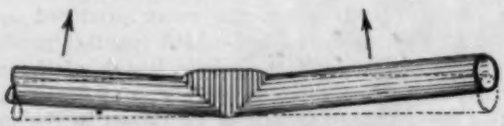


Fig. 5—Welding Bars with Single Bevel.

ation shown in Fig. 4, in which the branch tube is flanged to suit an enlarged orifice in the main tube, but the most satisfactory preparation is without doubt that shown in Fig. 3 where the hole in the main pipe or tube is flanged so as to form a butt weld with the branch. This preparation can, of

Fig. 6—Overcoming Warpage in Sheets.

course, be applied to the welding of tubes such as those shown in Fig. 2.

A distortion of a similar character to that obtained when welding manifolds is obtained when welding bars or rods which have been prepared with a single bevel as shown in Fig. 5. It can be avoided by making use of total preheating. The bar is placed on a fire and raised to a high temperature in the vicinity of the parts to be welded. In this manner the contraction effects are distributed along the bar and the distortion is practically eliminated. Hammering during the welding operation on thick material and after welding on thin material tends to diminish the contraction effects and produce good results. D. R.

ALL WELDED ICE CREAM TRUCKS

A new type of ice cream delivery truck (or wagon), which speeds up and greatly simplifies the delivery of ice cream to hotels, restaurants and retail stores, has been developed by the Rochester Ice Cream Company of Rochester, N. Y.

The truck or wagon, as the case may be, is so designed and constructed that deliverymen can remove the ice cream cans from a cold storage chamber without climbing up into the truck or wagon bed, and without having to wrestle with the heavy cans, which, in old-type trucks and wagons, are commonly buried in a mass of ice and salt. The improved design also enables the deliveryman to stand on the ground while shoveling out salt and cracked ice.

The cold storage chamber is made of sheet iron fabricated to the desired dimension, in this instance to accommodate about twenty 10-gallon cans. It is of oxy-acetylene welded construction throughout, and is simply a moisture-proof sheet iron box with a flanged opening that fits the frame for the heavy insulated door. The box is refrigerated by the cracked ice supply, which is dumped into another chamber immediately back of the ice cream storage. Just below the ice cream box, and midway between the front and rear wheels, is a space for storing empty cans. Where the tailboard would ordinarily be, a small door at the left gives access to the salt chamber. To the right of this door is a slightly larger one connecting with the cracked ice storage chamber.

The Rochester Ice Cream Company has experimented with various kinds of metal linings and with every known method of making joints. The first experiments were with light sheets lapped and nailed in the seams. Later, rivetted seams were tried. It was found that both nails and rivets worked loose and corroded around their heads, soon destroying the metal and rendering ineffectual any caulking that might be done. They experimented with tin, galvanized iron, copper, and sheet iron under almost every conceivable condition. Today the Rochester Ice Cream Company has definitely standardized on oxy-acetylene welded sheet

Welding Solves Ice Cream Delivery Problem.

iron of ten gauge, it having been found that this weight, while not excessive, possesses sufficient strength to stand up under rough service if the seams are joined by oxy-acetylene welding.

That the Rochester Ice Cream Company is satisfied with its solution of the heavy delivery problem is indicated by the fact that it has contracted for the rebuilding of all of its large fleet of trucks and wagons to conform to the new type described above. It is estimated that the speeding up of deliveries during the first season will more than pay for the conversion expenses, besides which there is the added consideration of greater cleanliness and improved service to patrons.

It would appear that there is a big opportunity, both for ice cream manufacturers and for the welding trade, in following the Rochester Ice Cream Company's lead in this new development. The "Rochester Idea" is not patented.

One of the Rochester Ice Cream Company's old-type delivery trucks is shown in the accompanying group of pictures. In the truck picture a barrel is seen in the narrow passage where the truckman stands while he digs out ice cream cans from their packing of ice and salt. The truck is good looking, better looking in the picture at least, than the wagon which is shown below, standing with its cold storage door open. However, the lower picture depicts the last word in the development of ice cream delivery wagons.

CHARACTERISTICS OF PURE IRON

The Manufacture of Commercially Pure Iron and Its Adaptability as Filling Material in Gas and Electric Welding

By C. A. McCune†

IN the first commercial application of welding, the lowest carbon welding metal was mostly desired as the metal was found to flow evenly and smoothly and welds made with it contained consistently less imperfections than were obtained with higher carbon metals on account of the absence of impurities such as were naturally present in metals of higher carbon content.

In the beginning, Norway iron was principally used as a welding material, but on account of the enormous increase in the application of the welding process in the United States and the shortage of the pure Norway product, it was necessary to produce in this country a similar metal, purer if possible, made on a more modern basis. Realizing that purity and uniformity were the principal factors in the Norway iron, commercially pure iron was later developed for welding purposes.

An interesting history of how the manufacture of commercially pure iron in the open hearth furnace came about was presented in a paper read at a meeting of the American Iron and Steel Institute at New York, May 27, 1921,[1] of which the following is an extract:

"The first announcement before a scientific and technical body that the manufacture of commercially pure iron had been successfully accomplished in the open hearth furnace was in a paper which was read at a meeting of the American Society for Testing Materials in 1911.[2]

"It cannot be questioned that there has always existed a demand for the purest obtainable iron. This demand has held steadfastly in the face of rapidly developing steel producing processes. The steady importation of Norway and Swedish irons throughout our entire metallurgical history up to the outbreak of the war in 1914 is sufficiently indicative of this fact. These foreign irons, however, that had to be laboriously worked down by a charcoal or puddling process were not suited to the large-scale tonnage operations which are made imperative by American conditions of labor and industry. It is natural, therefore, that our metallurgists should have been led to the consideration of adapting the open-hearth steel furnace to the manufacture of iron of at least an equal degree of purity as those types which were imported from overseas.

"Before progress along this line could be made, however, grave manufacturing risks had to be faced without much foreknowledge as to whether a successful, workable and salable product could be finally achieved. Every open-hearth man knows what is implied in raising the temperature of a bath two hundred degrees above the normal practice and maintaining this temperature until the carbon and manganese are run down to practically traces.

"The undertaking of pioneer work in this direction was certainly not altogether promising. Ledebur, the great German authority, had clearly stated in his compendious work in iron metallurgy that any such operation with the open-hearth furnace would be in vain if not freighted with disaster. In 1903, a very distinguished American metallurgist, H. H. Campbell, made an attempt at an open-hearth pure iron, and finished with carbon .025, manganese .040. Campbell did not follow up this step, however, and summed up his opinions in the following brief comment: 'These heats were made in a basic open-hearth furnace and their regularity both in chemical and physical character shows that we are dealing with a normal and definite metal and not with an accidental product. They were purposely made with the lowest possible content of manganese and it seems positively certain that the metal must be saturated with oxygen.' It is evident from the foregoing that so eminent an open-hearth man as Campbell thought that in carrying manganese down to .04 the procedure had gone as far as possible and that only an overburned metal was the result.

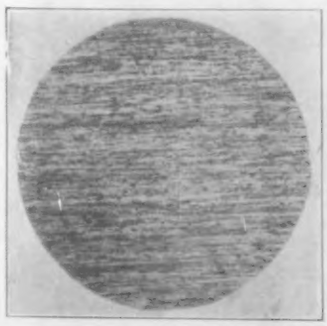


Fig. 1—Welding Rod Structure.

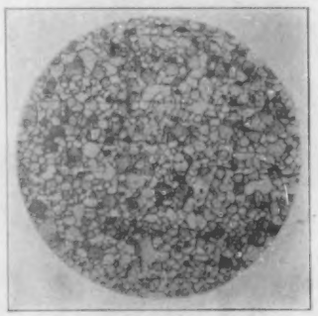


Fig. 2—Electrode Structure.

"Continuous progress in the art was made until finally it was proved possible to reduce the five ordinary impurities of iron (carbon, manganese, sulphur, phosphorus and silicon) to the point at which in the aggregate they did not exceed fourteen-hundredths of one per cent. At the same time special methods had to be studied to attain the maximum degree of degasification and the proper deoxidation.

Fig. 3—Slag in Electric Weld.

"Ingot iron made in an open-hearth furnace differs from the older irons in having a typical crystalline structure, a more definite critical temperature range, and more particularly in being essentially free from slag.

"As the experimental work progressed it was found that there were considerable differences in the practice of producing commercially pure iron as compared to steel practice, which materially added to the cost. In the first place, it required several hours longer to make an iron heat than a steel heat, and the final tem-

†*Sales Engineer, Page Steel & Wire Co.*

[1] *The Development of Commercially Pure Iron in the Basic Open-Hearth Furnace, W. J. Beck, Director of Research, The American Rolling Mill Co., Middletown, Ohio.*

[2] *The Manufacture of Pure Irons in Open-Hearth Furnaces, A. S. Cushman, Proceedings, American Society for Testing Materials, Vol. XI,* 1911.

perature of the metal was 200 degrees Fahrenheit higher than a heat of steel. Another marked difference was also found between the percentage yield of metal as compared with the percentage yield when steel was made. The percentage of metal produced was several per cent lower in the iron heats because the high temperatures and longer time employed in the manufacture of iron oxidized more of the iron, which was lost in the slag.

"In order to emphasize the importance of the selection of raw materials in the manufacture of commercially pure iron, attention is called to the fact that there are certain elements which if they exist in the raw material are not eliminated in the open-hearth furnace. Among these elements which cannot be eliminated are copper, arsenic, antimony, tin, nickel and cobalt.

"The purity of this product and the careful methods used in its

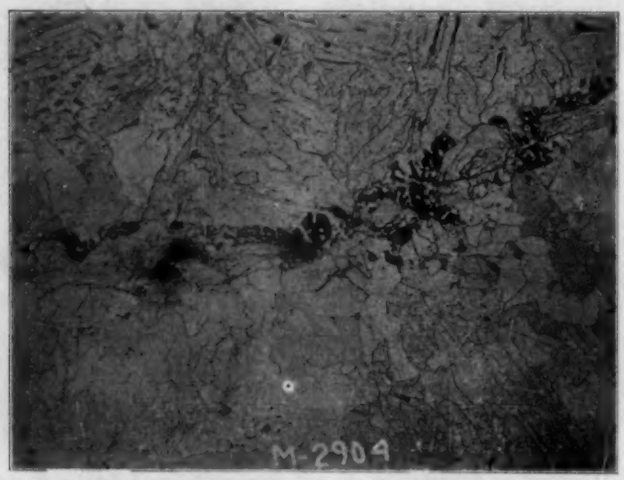


Fig. 4—Slag in Gas Weld.

manufacture make it more homogeneous than steel, and therefore it flows uniformly when heated to a melting temperature.

"The average analysis compiled from records covering a period of twelve months shows this iron purity to be 99.865 per cent. This takes into consideration the nine impurities,—silicon, sulphur, phosphorus, carbon, manganese, copper, oxygen, hydrogen and nitrogen."

This history of the development of commercially pure iron clearly shows that in the early days of metallurgy, analysis included determinations of only the elements which were commonly known as the BIG 5; namely, carbon, manganese, phosphorus sulphur and silicon. The aggregate of these was subtracted from 100, and the remainder indicated the percentage of iron. Previously very little attention, if any, was paid to degasification, but it was later found that by the elimination, as far as possible, of such gases as oxygen, hydrogen anud nitrogen, there resulted a more sound metal.

No great demand existed for welding material of other than foreign manufacture until it was no longer possible to secure this product in the United States in commercial quantities. It was not until the year 1914 that wire manufacturers of the United States had a real opportunity of proving that they could meet the demand for welding materials and that low carbon iron, particularly, could be produced here superior to any foreign product.

Welding Wires With High Carbon Content

The scarcity of genuine Swedish or Norway iron brought forth a vast number of substitutes of various analyses ranging up to .20 carbon. Very few of the contentions advanced for their use were accompanied by even sound logic let alone scientific data, making it necessary for the consumer to spend time and money experimenting with various grades of welding metal. It remained for the Emergency Fleet Welding Committee to first arrive at some definite specifications and limit of carbon and other elements for the selection of acceptable welding material.

There was less deviation in iron welding material used in oxy-acetylene welding than in the metallic arc process probably due to the fact that little was known of properly treating and processing iron and low carbon wire for electric welding. As the result of a certain amount of success it was considered by some much simpler to meet the extraordinary welding demands that existed with an ordinary steel wire than devote the considerable time necessary to work out this problem. As our knowledge of welding broadened, and time allowed for experiments, general improvements were naturally expected. Manufacturers engaged in the production of low carbon material fully realize that a low carbon content metal can be produced more uniform in analysis and with a better assurance of the elimination of impurities and gases. Many investigations have shown that an iron ingot is freer from deep seated blow holes and surface blow holes than the ordinary mild steel ingot. These defects in ingots have been found in the resulting wire in approximately direct proportion to the area and moreover may introduce seams and laps and general non-uniformity of structure. It, therefore, does not require any great metallurgical knowledge to realize that a sound ingot will produce a more homogeneous, slagless wire. This may be observed in Fig. 1 which shows the structure of oxy-acetylene wire and in Fig. 2 which shows the structure of electrodes.

Welding Wire of Same Composition As Base Metal

Research has shown conclusively that claims of the advantages of using welding material of a similar analysis as the base or parent metal, particularly when welding mild steel, are not sustained, and the reason for this can be fully understood, when it is considered that welding is re-casting metal. To expect a cast

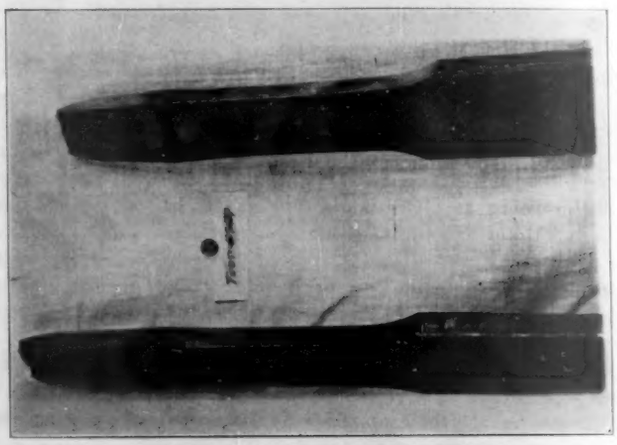


Fig. 5—Samples of Good Welds.

metal of a similar analysis to possess the identical physical characteristics of a rolled and specially treated sheet or plate, is asking more than could possibly be obtained.

Where we have attempted to secure welds with analysis approximately the same as the base mild steel, the welds have been found to be extremely brittle in relation to the base metal.

We have found that with a mild steel welding wire that does perform best a considerable chemical and metallurgical change takes place, and although the welding material may be of a low carbon or mild steel analysis ranging up to .20 carbon, which allows a very wide range, the deposits secured from this variety of welding material will analyze so close in carbon that there would remain no appreciable relation in the carbon content of the deposit secured, to the original welding material except in the case of very low carbon metals not over .06 carbon.

A considerable number of tests made on ½-in. plates of mild steel and commercially pure iron, to determine the analysis of deposits of mild steel wire (.08 to .20 carbon) and commercially pure iron (.02 carbon) by both the electric and oxy-acetylene process, showed an average deposit of .03 carbon, this figure fluctuating with the analysis of the plate.

The loss of the carbon occurs through the heat of the welding process and the presence of oxygen from the air. The carbon in the welding rod is exposed to the oxygen of the air and combines with it forming carbon monoxide or carbon dioxide gas which is very apt to be entrapped in the weld metal forming gas pockets or blowholes. Furthermore, the manganese in the welding rod is readily oxidized by the oxygen of the air, forming manganese oxide which may also become entrapped in the weld in the form of slag, presenting a possible combination of conditions which tend to produce defective welds. Further evidence that gases are recognized detriments is shown by the development of coated electrodes, one duty of the coating being to guard the molten weld metal against contaminations by the oxygen and nitrogen of the air.

When it is realized that in mild steel plates, etc., the carbon ranges from .08 to .25, a difference of 17 points, it would indeed be difficult to obtain a rod of such analysis that would meet the variation in the base metal even if this were a recommended practice, which it is not.

The fact that the original welding metal of mild steel is reduced practically to iron in the weld, and that there is no radical change in iron from the welding metal to the deposit, is evidence that carbon steel welding metals above .06 carbon have no advantages for the welding of mild steel parts.

Gaseous Inclusions

Films of oxide (see Figs. 3 and 4) between the grains or blow holes in the weld are very important factors in producing defective welds, but oxides are not alone or entirely due to the burning out of the carbon, but just as frequently result from the occluded gases contained in the welding wire or the base metal. The welding heat disturbs and expands the gases present and in endeavoring to liberate themselves the molten metal is ruptured and exposed to the air—making oxidization possible in the channel created. In most cases this channel is at or near the edge of the "V" where there is usually found a mixture of carbon of the base metal and welding metal, and as this point cools more rapidly than the center of the welds, it is the first to freeze and trap any oxide and gases. The disturbance, however, continues until the mass has cooled throughout. Naturally this all takes place very rapidly and in a very small space, but it may be compared to a heat of steel of the analysis in question where it is possible to observe the freezing of the tops of ingots of 5,000 pounds weight after pouring from the ladle and later, to view the cross-section of the ingot itself. This cross-section shows that blow holes are present, which, as a general rule, is expected and not considered detrimental for the purpose intended as the ingot is later to be re-heated, rolled and otherwise processed, but which is not practical with mild steel welds. Due to the fact that material deposited by the fusion welding processes is similar to a casting, it is essential that the deposit be sound, free from gases and slag inclusions in order that it may consistently approach the characteristics of the base metal.

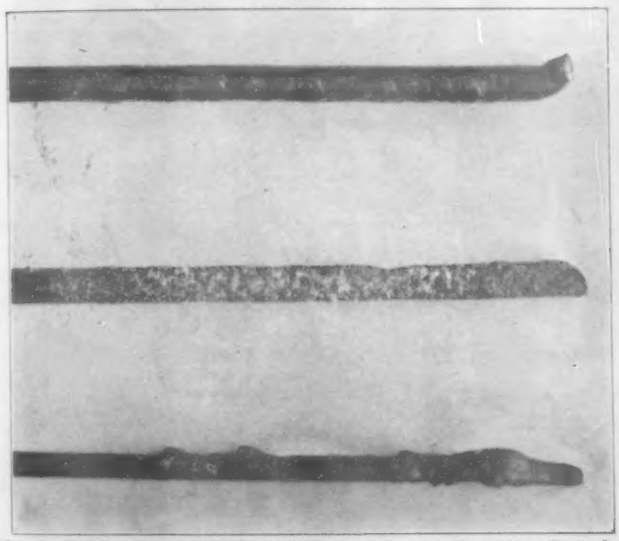


Fig. 6—Melting Test of Welding Wire. Only the Top Wire Had the Smooth Flowing Qualities Necessary for Good Welding.

Commercially Pure Iron Welding Wire and Plate

It has been proved beyond question by innumerable practical applications, test specimens, etc., that commercially pure iron wire of correct physical properties possesses every essential that could be advanced for a suitable metal for welding mild steel plates, shapes, etc., by either the oxy-acetylene or electric arc process. Furthermore, continued research develops that whereas the efficiency of a weld in commercial steel plates welded with commercial steel wire may vary, a weld produced with commercially pure iron wire in commercially pure iron plate will consistently approach the characteristics of the plate establishing the fact that chemical uniformity of the plate and wire should receive the most careful consideration. The welder is frequently handicapped by attempting to successfully weld (according to best established practice) a plate containing gases and other impurities.

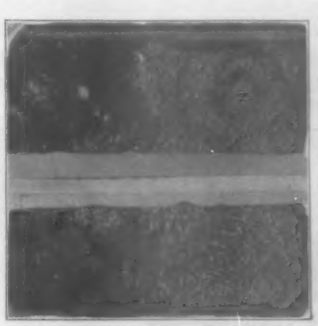


Fig. 7—Gas Weld Made With Non-Uniform Rod.

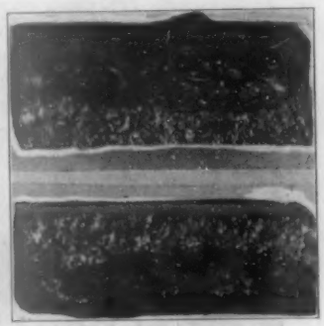


Fig. 8—Electric Weld Made With Non-Uniform Electrode.

Test of Good Welding Wire

As a general rule laboratory facilities are not always available to the consumer for testing welding wire. Besides, the preparation of test samples entails considerable time and expense. Therefore, it is necessary that a more or less rapid practical test be developed. The following method is offered in the hope that it will be of assistance to those interested and at the same time leading to further investigation and development. This test is made by laying the wire flat on a clean surface and applying a standard oxy-acetylene welding flame to it in such a manner as to heat it up for a distance of about six inches plying the flame back and forth until the wire is red and then slowly melting it, moving the flame so that the wire melts only half way through its diameter and thereby avoiding picking up anything foreign to the wire itself. The smallest tip available should be used, care being taken to produce a neutral flame.

If the flame is withdrawn as soon as the metal begins to melt the impurities can readily be seen being thrown off in the form of sparks, or a boiling action will take place in the case of inferior material indicating undesirable elements such as gases and slag, and in some cases the metal will not flow together but tend to "run away." On cooling the metal will present a spongy appearance (Fig. 6). In the case of clean metal practically free from impurities, the wire will melt and flow together evenly without displaying any disturbing action.

This test applies to both gas welding rods and electrodes. It does not, however, indicate the actual welding characteristics of an electrode, but will give sufficient evidence of what may be expected in a weld deposit from such metal, notwithstanding the fact that the electrode may, in a good many instances, pass operating and other physical tests.

This melting test may also be conducted with electric welding apparatus by "freezing" the electrode to the work or plate regulating the curent to the size of the wire so that the wire heats up gradually and melts uniformly the full length of the wire. If the current is too high the wire will melt close to the plate only

and not present sufficient melted surface for observation. It is, therefore, necessary to adjust the current so that the wire slowly heats up and melts its entire length.

The tensile strength of a welding wire has been taken by some as an indication that a wire of a given tensile strength will produce a weld of equal strength. All available data proves conclusively that there is no relation between these figures.

Conclusions

Experience has shown that the success or failure of a weld depends on what might be termed the BIG 5 of welding, all of which are practically of equal importance, namely, the welder, which includes methods of welding, design of weld, welding equipment, metal to be welded and the welding wire. Metallurgy distinctly proves that certain elements are detrimental. Therefore, it is only logical to assume that dependable welding material should be as free as possible from these injurious elements.

Under the heading of what constitutes a good welding metal —although the last word may not be written for a considerable time—we would indeed be confident that if what might be termed the BIG 5 of welding wire were assured it would fulfill its obligations in the production of uniformly successful welds: A wire,

First—that produces a weld approaching the general physical characteristics of the base metal.

Second—that does not contain or tend to create gases.

Third—that is free from slag or slag forming ingredients.

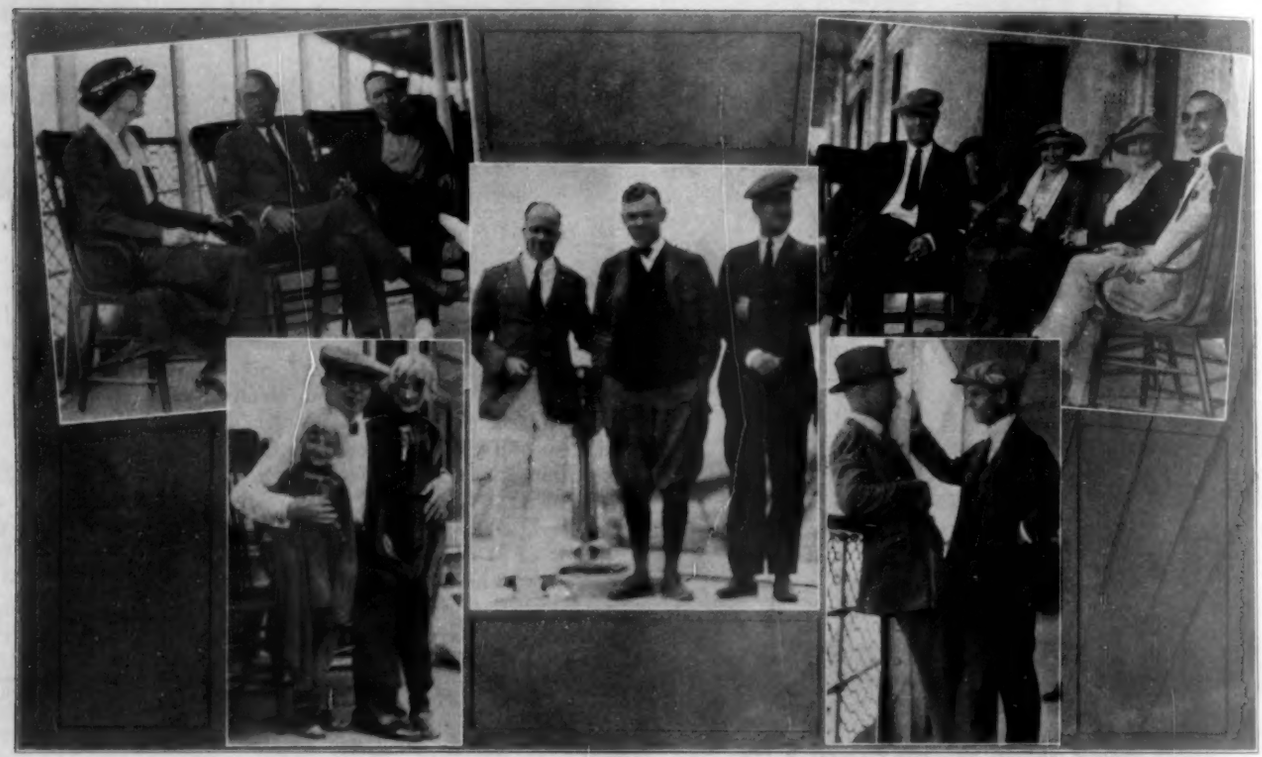
Fourth—that is chemically and physically uniform.

Fifth—that embodies ease of operation.

Welding is an application of metallurgy and engineering and its study should be so approached. Any common baling or fence wire will no more meet the requirements of a dependable welding material than would metal of this analysis serve as tank plate or locomotive fire box steel. Science, sound judgment and common sense prevail in all materials of construction and in welding apparatus, and therefore must apply equally to welding material if we are to be consistent.

GAS PRODUCTS ASSOCIATION CONVENTION WELL ATTENDED

ONE of the most successful and pleasant mid-summer conventions in the history of the Gas Products Association was held at Mackinac Island, Michigan, during the week of July 18th to 22nd.



Gas Producers Aboard the Manitou—Left: Faulhaber Explains Golf to the Russells; the Bostonian Gentleman at the Bottom is Willard Foster from Wild & Wooly Oklahoma; Center: E. L. Mills, Author of the Panorama Picture Below, in Serious Conference with Epperson and Luening; Right, E. D. Findlay and Party Looking Sorry Because They Made the Boat Wait; Lower: Talking the Oxygen Out of the Air.

These mid-summer conventions have been established as an annual opportunity to bring all the members of the Association together for the purpose of getting better acquainted with each other and, at the same time, transact important business which requires the meeting of as many members as possible.

The Captain Obligingly Loaned His Private Roof Garden for This Bird's Eye View of the Convention Party, and Almost Three Dozen Members

Nearly forty members were present for the boat trip which was the first number on the Convention Program, the S. S. Manitou carrying the party to the Island. As this lake voyage required twenty-four hours, headquarters were established on the boat and some progress had been made towards transacting the necessary business before the arrival of the party at Mackinac on the 18th. An open meeting was held on the afternoon of Tuesday, July 18, at which time important suggestions were laid before the members for consideration by the associate members and guests who were present at the convention.

At this meeting, the subject of the American Welding Society was discussed at considerable length and the impression seemed to prevail very strongly that each member of the Gas Products Association should also be a member of the American Welding Society and should give the society the best individual support possible. Although there was no formal action taken the interest that was aroused indicates that the American Welding Society can confidently expect an increase in membership from the group. The Association itself and several of its members are already members of the American Welding Society.

The remainder of the week was devoted almost exclusively to business sessions which enabled the members to discuss the problems and policies of the Association at length and exchange important and helpful information.

Mackinac Island is an ideal location for a convention of this kind because of the abundance of historic and scenic interest and those who attended were favored by most ideal weather conditions.

Ample provision was made for the entertainment of the ladies, the associate members and the guests who were in attendance so that the convention was thoroughly pleasant as well as profitable to the active members in attendance.

One of the important pieces of business transacted was the acceptance of two applications for membership from the Tulsa Oxy-Hydro Company, Tulsa, Okla., and the Memphis Oxygen Company, Memphis, Tenn., and the acceptance of a new associate member.

The officers elected for the ensuing year are M. L. Goodrich, Swift & Company, Chicago, President; E. A. Faulhaber, Burdett Oxygen Company, Chicago, First Vice-President; C. O. Epperson, Compressed Gas Corporation, Denver, Second Vice-President; H. W. Kurtz, Secretary.

The attendance of members and guests at the Convention include the following:

M. L. Goodrich, Swift & Company, Chicago; E. G. Luening, Consulting Engineer, Chicago; H. G. Austin, National Oxygen Company, Chicago; E. A. Faulhaber, Burdett Oxygen Company, Chicago; H. B. Pearson, Burdett Oxygen Company, Chicago; J. B. Burdett, Burdett Mfg. Company, Chicago; C. O. Epperson, Compressed Gas Corporation, Denver, Colo., and Mrs. C. O. Epperson; E. D. Findlay, Acme Oxygen Company, Chicago, Mrs. E. D. Findlay and Miss Peagan; A. S. Bordeaux, Michigan Ox-Hydric Company, Muskegon; A. J. Russell, Bettendorf Oxygen Hydrogen Company, Bettendorf, Iowa, and Mrs. A. J. Russell; C. J. Haines, Electrox Company, Peoria, Ill.; J. R. Brandt, Indiana Oxygen Company, Indianapolis, Ind,: W. H. Girdler, Kentucky Oxygen Hydrogen Company, Louisville, Ky.; F. B. Wilkinson, Logansport Oxygen Company, Logansport, Ind.: H. N. Smith, Memphis Oxygen Company, Memphis, Tenn.: Walter Verkamp, Ohio Electrolytic Oxygen Company, Cincinnati, Ohio; Willard Foster, Tulsa Oxy-Hydro Company, Tulsa, Okla.; H. J. Mueller, Universal Oxygen Company, Sheboygan, Wis., and Mrs. H. J. Mueller; A. F. Jenkins, Alexander Milburn Company, Baltimore, Md., and Mrs. A. F. Jenkins; C. L. Gulick, Wm. Wharton, Jr., & Co., New York City; E. L. Mills, Bastian-Blessing Company, Chicago; W. G. Swaney, Pittsburgh Reinforced Brazing & Machine Company, Pittsburgh, Pa.; H. S. Card, *The Welding Engineer,* Chicago, and Mrs. H. S. Card; C. E. Philips, Purox Company, Detroit, Michigan; C. M. Carpenter, Standard Water Systems Co., Cincinnati, Ohio; M. Keith Dunham, Chicago, and Mrs. M. Keith Dunham; James Dunham, Boston; H. G. Amling, Chicago; H. W. Kurtz, Gas Products Association, Chicago; H. W. Cook, Acetylene Journal, Chicago.

WELDING LAMINATED SPRINGS

The spring plates of laminated springs are usually manufactured from the highest quality of steel containing between 0.5 and 0.8 per cent of carbon. The steel for the top plates which are welded at the eye contain between 0.45 and 0.7 per cent of carbon. All plates are carefully hardened and tempered.

The operation of hardening is performed by suddenly cooling the metal from a bright red heat, and the degree of hardness produced depends first, upon the carbon content, increasing as this rises; secondly, to a less extent, upon the temperature from which the steel has been quenched; and thirdly, upon the rate of cooling over the critical points.

In the oxy-acetylene welding of steel it is customary to use a welding wire of low carbon content with practically no hardening qualities and consequently no spring properties. It should also be noted that the carbon content of the spring plates brings them in the class of steels known as high-carbon steels, and the weldability of such steels is, from the mechanical properties point of view, practically nil. For example, when attempting to weld steels approaching 0.8 per cent of carbon the metal becomes "burnt" and the metallurgical changes that take place produce joints which are porous and full of intercrystalline substances which are chiefly oxide films. Such joints cannot be restored by heat treatment and consist of distinct lines of weakness in the metal.

It is obvious from this that the welding of spring plates by the oxy-acetylene process is not to be recommended, except for emergency repairs. In such cases a high carbon steel welding wire should be used. The plate should be beveled and welded from one side only with a slight reinforcement. The flame should be carefully regulated and the size of blowpipe should be such as to rapidly melt the metal, the line of welding previously being raised to a red heat. After welding the joint should be hammered at a cherry red heat and then annealed at a yellow heat. After cooling, the joint should be annealed a second time at a medium cherry heat. It is advisable to make use of wet asbestos on either side of the weld during the welding operation to prevent the heat being conducted along the spring.—*D. Richardson, in the Acetylene and Welding Journal.*

Were Induced to Stand Still and Look Pleasant. Business Must Be Good; There Don't Seem to Be Any Pessimists.

AIN'T IT A GRAND AND GLORIOUS FEELING?

FOR A WELDER

(With apologies to Briggs)

WHEN YOU RUN UP AGAINST A JOB THAT STUMPS YOU AND—
YOU ASK SOME OF YOUR WELDER FRIENDS FOR ADVICE, AND—
GOSH A' MIGHTY
I GUESS IT'S JUNK
SOME CRACK BILL!
THEY ARE ALL A-W-O-L AND—
TOO MUCH FOR ME
I PASS 'OL MAN
HEY! COME BACK
YOU REGRET YOU HAVE NOT PRESERVED A COMPLETE FILE OF THE WELDING ENGINEER AND—
WELDING ENGINEER
THEN YOU HAPPEN TO REMEMBER—
AH! I HAVE IT, MY—
THAT YOU HAVE A COPY OF THE SECOND EDITION OF THE WELDING ENCYCLOPEDIA
OH-H-H BOY! AIN'T IT A GR-R-R RAND AND GLOR-R-RIOUS FEELIN'?
TVA
TA-TA TAY
THE WELDING ENCYCLOPEDIA SECOND EDITION

The Last Word in Welding—Yours for $5.00

THOUSANDS of welders are using The Welding Encyclopedia, 1921 edition, every day as a reference work on all of their welding problems. This book is recognized as the standard authority on all of the welding processes.

The demand for additional information, and for information of a specialized character has made it necessary to revise The Welding Encyclopedia completely. Accordingly, the second edition represents an entirely new treatment of the subject. In addition to the information contained in the first edition, the new book will furnish a vast fund of specially prepared information on the welding processes as applied to the important industries. It also has been made to include all of the important discoveries pertaining to welding, which have been made during the past two years.

Scores of special welding jobs including both production work and repair work are also discussed in detail.

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After reading the advanced proofs of one portion of this book, one of the leading authorities in United States on Welding makes the following comment:

"I reviewed with interest the excellent material contained in the advanced proofs of the second edition of The Welding Encyclopedia. This material, in my opinion, faithfully reflects the viewpoint of many welding engineers, as well as contributes information of decided value to users of welding equipment."

At a recent meeting of the Executives Committee of the American Welding Society, the following resolution was passed:

"That the American Welding Society endorses The Welding Encyclopedia, as it believes its contents are of great value to all interested in welding."

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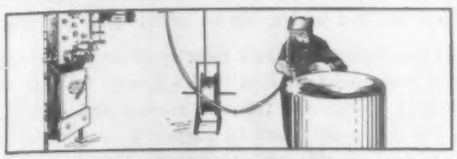
HERE is a complete and comprehensive set of instructions for the boilermaker—a fund of up-to-date information on the production and repair of boilers. Both oxy-acetylene and electric arc welding are discussed. It puts the most modern boiler welding practice at your fingertips.



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PRESSURE tanks and storage tanks can be manufactured better and cheaper by welding than by riveting. THE WELDING ENCYCLOPEDIA describes the latest and most approved methods of constructing tanks with the torch and with the arc. Years of experience in tank welding are available through this chapter.

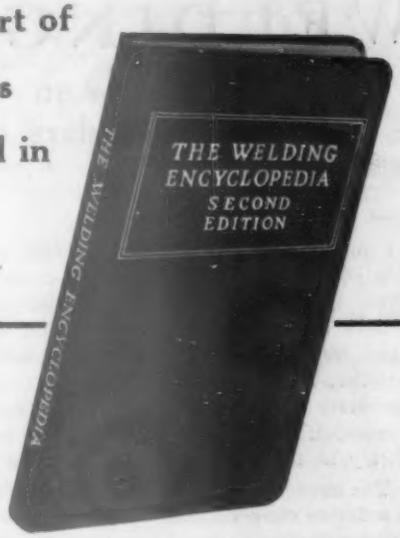
PIPE LINE WELDING

THIS chapter deals with the autogenous welding of oil pipe lines, water pipe lines, pressure pipe lines, etc., the preparation of the work, organization of welding gangs, welding procedure and cost data. It is a concise summary of all available data on the subject of pipe welding.

CUTTING

THE subject of cutting is nearly always treated in a casual manner and the work is given to unskilled helpers. In this book a discussion on "Cutting" tells how EXPERT cutters are developed. It also treats of automatic and mechanically controlled cutting torches and their uses. Every plant which operates a cutting torch needs this reference material on cutting.

Every Phase of the Art of Welding Metals is Completely Treated in This Book



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THE WELDING ENCYCLOPEDIA

SECOND EDITION

Is an Indispensable Reference Work for:

Welding shops, garages, railroad shops, shipyards, boiler shops, steel plants, foundries, oil fields, street railways, technical schools, vocational schools, industrial libraries, automobile factories, mining camps, lumber camps, plant managers, superintendents, and foremen in all metal working industries.

This Edition Contains:

Definitions of all words, terms, and trade names used in the welding industry.

Complete instructions for oxy-acetylene welding, electric arc welding, resistance welding and thermit welding. The applications of these processes to the welding of different metals are explained in detail.

Complete instructions for the use and care of all kinds of welding apparatus.

Rules and Regulations regarding the applications of welding and the installation and use of welding equipment.

A valuable collection of charts and tables of welding information.

Detailed instructions for dozens of difficult welding jobs which are commonly encountered in practice.

Special treatments on the welding of tanks, boilers, refrigerating machinery, rail joints, automobile repairs, pipe lines, sheet aluminum, locomotive cylinders, automobile cylinders, radiator repair work, railroad repair work, oxy-acetylene cutting, etc. A few of these are commented on briefly on this page.

A catalogue section in which the standard lines of welding apparatus and supplies are described.

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WELDING SHEET ALUMINUM

How an Automobile Body Manufacturer Trains Welders to Make Perfect Seams with the Torch

Detroit

Dear Ed:—

I just picked up a thing or two that I figured might help your cause along a bit. We stopped in at a body plant where they were building aluminum bodies for automobiles. Believe me Ed, when I tell you that while I have watched many welders handle aluminum, of both the cast and sheet varieties, I've never seen a man who could handle his sheet aluminum like this fellow we saw yesterday. It was simply wonderful; words failed me and I just stood there fascinated. I'll try to tell you how he went about it.

The material being welded looked like fourteen gauge sheets. In order to show me exactly how the welding took place, sort of a demonstration was given on some scrap. Two strips were laid upon the bench, with their edges separated a good sixteenth of an inch all along. The "filler-rod" was a piece sheared from the same stock. It measured about a quarter of an inch wide. The welding tip used seemed to me to be almost too large for such thin material, but it worked nicely. It was a medium sized tip. Just before the welding started, the end of the "filler-rod" was heated up a bit with the flame and then plunged into the powdered sheet aluminum flux. You might say that this is the usual procedure but here is where a little trick is used. The flame is directed on the end of the rod containing the flux. The rod, being held in an upright position, allows the melting flux to run down its sides and coat the rod for perhaps eight or ten inches. Then the welding commences. The flame is brought down to the edge of the sheet and the "filler-rod" held in the little opening between them. As the "neutral" flame strikes the metal it melts it, and the flux on the "filler-rod" dissolves the oxide, allowing the edges to unite. After the weld is started, the tip of the torch is turned a little so that it has a tendency to point in the direction to be welded. This fellow simply handled that stuff with no effort at all. At the rate he was going I imagine that he was welding around two feet per minute. And the weld! it was just about perfect. Have you ever seen a "lead burner" run a seam on sheet lead? Well, this weld was in the same class; the ripples just as smooth and uniform as could be and furthermore, there was a nice continuous bead formed on the underside of the weld which made a fine reinforcement all the way along.

I couldn't quite understand, at first, how this bead could form so nicely on the underside but they informed me that like in many other things there was a certain knack in handling work of this kind. When handled in the correct manner a bead could be formed but care had to be exercised or the metal would sag too much. First it is necessary that a strictly, sheet aluminum flux be used. A good flux of this kind can not be purchased for much less than four or five dollars a pound. A flux costing any less, they have found to be useless, as the chemicals employed in compounding were quite costly and if a substitution were made, the efficiency of the flux was lessened. The flux has to possess the property of being able to dissolve the oxide that forms on aluminum and do it very fast when the metal is hot. Aluminum, this lad went on to explain, was a very peculiar metal. While it melts at rather a low temperature, yet it's a great conductor of heat. This means that if the same sized welding tips are used as on cast iron and steel it will require a much longer time to melt it. For this reason a larger sized tip is used, to sort of counteract this conductivity. Another property of aluminum is that it loses all its strength as the melting point is approached and it will collapse unless means have been taken to "back it up." Through his years of experience he had found that when working on sheet aluminum, the things to be fussy over are: The flux, use the best there is; the size of the tip and the angle at which the flame strikes the work, and lastly the speed at which the weld could be made. Evidently there is a relation between these things. The right combination can only be determined by practice it seems. When once attained, any operator can readily weld sheet aluminum with a fine, uniform ripple and the reinforcing bead will automatically form on the underside as previously described.

There was just one point I wasn't exactly clear on and that was why the flux had to be melted and allowed to coat the "filler-rod." When I mentioned this, he smiled and said that the only reason for doing this was to permit a longer stretch to be welded at a time without stopping, thereby giving a smoother looking weld than if repeated stops were made to pick up more flux.

It beats all Ed, how simple some things prove to be, when explained. Sometimes we stop and wonder how we can ask such simple questions, but at that I'm going to stick right to my old policy and if I don't understand a thing, I'm going to ask.

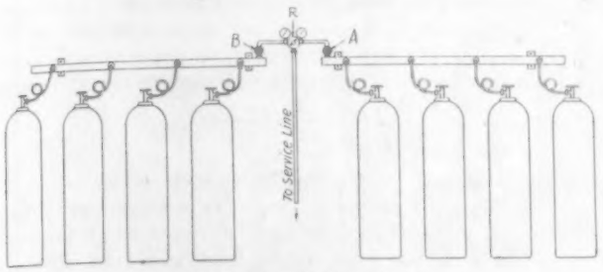
"Doc" and I made a number of other stops but there really wasn't anything outstanding to be found in any of them. It's strange what creatures of habit we all become. Doing everything the same way as the other fellow. In knocking around I can't help but stop and wonder why, with so many people in this world, there aren't more ways of accomplishing the same end.

Come to think of it, I did see another stunt that may strike your fancy. It's not exactly a new idea and it's not about actual welding either but from the looks of your shop, you'll have to dope out something like this before long, to operate more efficiently. The way your men have to haul their tanks around and change regulators all the time isn't right and I'll bet you know it too.

One of the places we stopped at had a manifold for the oxygen cylinders. It was of a very simple construction and with a few fittings on hand it wouldn't take long to build one. I'm making a bit of a sketch for you, to show the general idea. On this manifold there were connections for hooking up either four or eight cylinders. You can see how it is put together. The main lines are made of extra heavy, seamless steel tubing with the connections screwed and then brazed in place. Cross-straps, or other means, are provided to mount on a wall. The connections between the cylinder valves and the line are made of extra heavy brass tubing, with the fittings on each end screwed and either brazed or sweat in place. All these fittings are called upon to stand a pressure of two thousand pounds, so care must be exercised in picking material that is in no wise defective. On the cylinder end of the tubes a swivel connection must of course be used and in order to prevent the tube from twisting off, when tightening, a wrench hold of some kind should be provided on the tube end of this swivel connection. This tube-wrench, as it might be called, is chained to the manifold, to insure its always being there when needed. Now, in changing cylinders it is necessary to use two wrenches; this tube-wrench to protect the tube

and another for the swivel nut. A loop is formed in each tube to take up any vibration or slight variation in the connections.

The regulator (R) can be of the ordinary type, but a cutting regulator is much preferred, as it will pass a larger volume of gas without freezing. One of the gauges will indicate the pressure delivered to the line and the other, the pressure in the cylinders. By interposing shut-off valves, as shown at (A) and (B), each set of cylinders can be used independently of the other or both used at once. I would imagine that the best way would be to use only one side at a time. When that side was drained, the shut-off valve is



Useful Manifold System.

closed and the one on the other side opened. In this way all the gas is used and the service is continuous. The empty cylinders can be changed at will, without interferring, in the least, with the operation.

The regulator can be set to deliver whatever pressure is desired to the line. I learn that in some places a working pressure is maintained and the welders merely attach their hose to needle valves along the line which goes through the shop. In other places, rather a high pressure is maintained on the service line and line regulators are installed at the various stations throughout the shop. That was the case in this place and I would imagine that it would be the best for more shops where various types and sized jobs are handled, requiring different pressures on the line. Of course, if all the work is the same, such as might be found in some manufacturing lines, and the same kind of equipment used throughout, it might be exceptional and the regulators dispensed with. But at that, unless the service line were a large one, the turning on and off of the gas by the different operators, would no doubt cause a variation in the flames being used.

I inquired if the manifolding were to be considered as satisfactory. "Satisfactory?" yelled the foreman, "why that's the best thing the company ever did in this department. Before we had this system, we were dragging tanks around here all the time, wasting a lot of gas and valuable time. Now we have forgotten all that. Another thing, we have ended practically all our regulator troubles. The fellows really never did understand those things and they were out of commission half of the time. It would often happen that a tank of gas would be tipped over because someone failed to hook it in place and naturally the regulator would suffer. If that wasn't the case some operator would let his regulator fall when changing tanks or turn on the full pressure when his adjusting screw was turned way in, or perhaps get a lot of dirt or filings in the seat. There seemed to be no end of trouble, if it wasn't the regulator itself it was the gauges or loose connection. Let me tell you this;—we operate ten welding stations in this department and we always have no less than twenty oxygen regulators, because half of them were always being repaired. Now, things are different, we have a little rest on that score. Practically no attention is required on the line at all, because as you can see, the regulators are screwed in place and are never changed. Only one man handles the tanks on the manifold and even if the master regulator should leak or creep a little, that don't harm anything for each operator has his own line regulator at his station. This idea is just as different from the old system as night is from day, and as far ahead, as the auto is of the horse. I'm strong for it, if that answers your question."

So there you are Ed. It's just a suggestion and I hope you'll accept it as such. As for me, I'll have to start throwing my things together as my sojourn in Detroit nears an end. As friend "Doc" would put it, "a la radio," I'm signing off.

As ever,

SHEP.

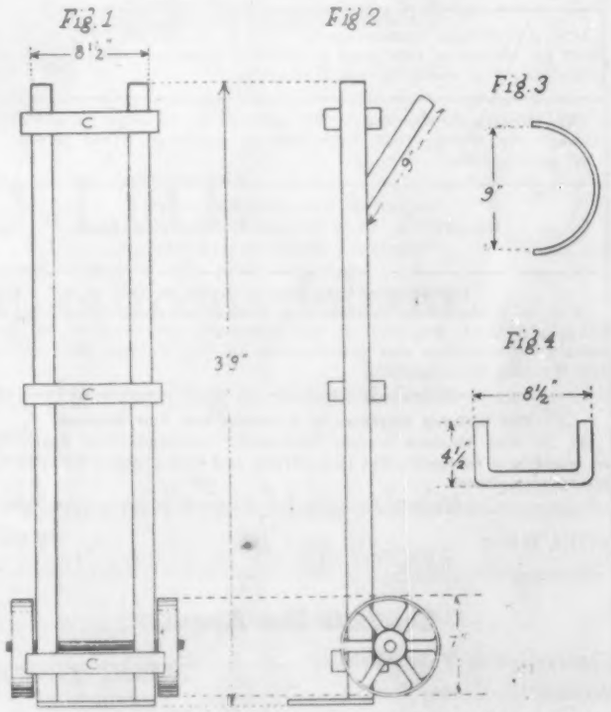
A USEFUL WELDING ROOM TRUCK

Editor:

The accompanying sketches show a truck which we built for the purpose of conveying oxygen and acetylene gas drums about the shop. This is a single drum truck.

Fig. 1 shows a front elevation of the truck, the upright pieces being made of 1x1x⅛ inch angle iron. The cross pieces C which form the cradle for the drum are made of ¾x⅜ inch channel steel curved as shown in Fig. 3. These pieces are curved to a 4½ inch radius or to the segment of a 9 inch circle. The wheels may be of any suitable size, care being taken that they are not too small. From six to nine inch diameter makes a good size.

Fig. 2 shows a side elevation of the truck and also shows the steel nose which is placed at the bottom of the truck as a support for the drum, this steel nose piece being formed as shown in Fig. 4. All joints in this truck were made by welding, the cross pieces marked C being welded to the uprights, the nose piece, Fig. 4, being formed of a single strip of 1x¼ inch flat steel and welded across the ends of the bottom of the uprights. A handle as shown at H is welded to the left hand upright, this handle being made of ¼x1¼ inch flat steel. The axle supports are made of 2x¼ inch flat steel welded to the uprights, and holes at a suitable point are provided through which the axle shaft is placed.



Details of Welding Truck.

This is an extremely convenient truck to convey compressed gas drums around the shop and when it is necessary to take a welding set through a narrow passage, this truck is much more convenient than the ordinary two drum welding truck.

E. Kilburn.

The Welding Engineer

Reg. U. S. Pat. Office.

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VOLUME 7 AUGUST 1922 NUMBER 8

Contents For August

Contraction in Tube Welding..... 18
Welded Ice Cream Trucks..... 20
Characteristics of Pure Iron..... 21
Gas Products Association Convention..... 24
Welding Laminated Springs..... 25
Welding Sheet Aluminum..... 28
Useful Welding Room Trucks..... 29
Editorials 30
Australian Welders Organize..... 32
A. W. S. Executive Committee Holds Important Meeting 32
Electric and Magnetic Tests for Welds..... 34
Flux Coatings for Electrodes..... 37
Country Welding Shop Handles Difficult Jobs..... 38
New Form of Thermit Rail Weld..... 40
Oxy-Acetylene Used in Metal Coating..... 42
Railway Men Hear Welding Story..... 46
Current Welding Literature..... 48

Come to Chicago in October

CHICAGO has been designated as the meeting place for the American Welding Society, in October, and a program of papers and discussions has been arranged which will make attendance at the meeting well worth while for every member as well as for all others interested in welding. A generous turn-out will of course mean a great deal to the success of the Fall meeting, since it will put so much more information at the disposal of those who attend the meetings. It will also further the progress of membership work for the balance of the year, offering as it does such a good opportunity for the merbership committee of the various sections to get together and organize their efforts to the best advantage. If you are interested in welding and want to do your bit toward advancing the art, a good way to prove it is to be on hand when the convention starts and stay to see it through.

Selecting the Base Metal

ONE advantage which the production welder often has over the repair welder is that he is in a position to specify the metal which is to be welded, a matter which has more bearing on securing good welds than would be supposed from the lack of attention given to it. It is a point which should always be observed in the case of production welding, because very often the weld can be made easier and cheaper by slightly changing the specifications of the material which is to be welded, or the design of the joint which has to be made. The selection of tank steel for welded tanks, for example, makes a great deal of difference in the quality of the finished joints, and there is plenty of latitude for the manufacturer in making his choice. It is better to provide as nearly ideal welding conditions as possible than to risk the results that may come from a mediocre workman welding on a rather difficult metal or alloy. If welded joints are to be used, let them be good ones.

The Report of the Rail Joint Committee

ONE of the most interesting of current documents on welding is the recently published report of the Committee on Welded Rail Joints. It may well be said to represent the opinions and practices of a group of the best known rail welding experts in the country, and if this is true the report as a whole must indicate to the man who thinks he stands alone in the knowledge welding that we all have a lot to learn. The members as a whole have been exceedingly faithful in preparing exhaustive answers to a very elaborate schedule of inquiries pertaining to their own welding operations, and these replies have been carefully compiled so that comparisons of opinions and practices may be made easily. On the majority of points covered in the inquiry the replies are in agreement, yet there are enough differences expressed on other important points to show that there is still a real need for more research, and the number and nature of the questions submitted for further research will certainly mean a lot of hard work and expense before the work of the committee is completed. The thoroughness with which the investigation is being handled deserves the commendation of the industry. The method of handling might well serve as a guide for other research committees.

Service in Selling

SOME salesmen of welding apparatus could afford to give their torches away if the customers were willing to pay for the full value of the service which the salesmen render. These men are not merely selling pieces of brass and copper, they are selling the performance of the neat little advice they demonstrate. When a real welding expert goes into a shop or factory and shows the owner how he can cut down expenses by slight changes in operating methods, and

PREST-O-LITE

Adds Two New Links to its Chain

Prest-O-Lite is pleased to announce the opening of district sales offices at Baltimore and Kansas City.

These two new district offices are evidence of Prest-O-Lite's desire to place every facility within convenient reach of its customers.

An inquiry to our nearest sales office will bring you information concerning our latest sales and service plans.

THE PREST-O-LITE COMPANY, INC.

General Offices: Carbide and Carbon Building, 30 East 42nd Street, New York
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then sticks around long enough to be sure that the workmen have mastered every detail of his ideas, the least the shop owner can do is to buy that salesman's goods for the work in hand. Service of this sort is responsible for holding some of the best welding equipment accounts. It is difficult to sell welding equipment without it.

AUSTRALIAN WELDERS ORGANIZE

Oxy-Acetylene Welding has advanced to such an extent in Australia, that in the City of Melborne at least there is enough welding activity to support a local associaion. This association is known as the Victorian Oxy-Acetylene Welding Association, and has allied itself as a section of the Victorian Automobile Chamber of Commerce. The reason for this alliance is that the welding industry is very closely interwoven with the motor industry in that locality.

The objects of the association, as outlined in a recently published set of rules, are:

First—To enable by all legitimate means to improve the status of the trade, to protect and serve the interest of all members.

Second—Organization of instructions in Oxy-Acetylene Welding, examining and testing welders' samples and issuing certificates of proficiency in welding.

Third—Facilitating the dissemination of technical information amongst its members.

Mr. E. J. Raymond is secretary of the association, with headquarters at 312 Flinders St., Melbourne, Australia.

AIR REDUCTION SALES COMPANY ANNOUNCES EXPANSION PROGRAM

Air Reduction Sales Company has under way a program of plant expansion designed to enable the company to render increased service in important industrial sections. Sites have been purchased for an acetylene plant at Birmingham, Ala.; an oxygen plant at Milwaukee, Wis.; and an acetylene plant and a calorene plant at Pittsburgh, Pa., these last two plants augmenting the recently completed oxygen plant in the same city. Construction of the plant at Birmingham already has begun, and plans are well under way for the erection of the plants at Milwaukee and Pittsburgh. In addition to these new plant installations, Air Reduction Company's facilities for producing oxygen from the air will be enlarged in Buffalo and Minneapolis. The estimated cost of the proposed operations is over half a million dollars. The completion of the new construction will bring the total number of the company's oxygen plants throughout the country up to twenty; the acetylene plants to eleven; and the calorene plants to two. These are in addition to the Air Reduction Apparatus plant in Jersey City, N. J.; the recently acquired Davis-Bournonville apparatus plant, also in Jersey City; and the Ivanhoe, Va. plant of the National Carbide Corporation.

EXECUTIVE COMMITTEE OF AMERICAN WELDING SOCIETY HOLDS IMPORTANT MEETING

At a meeting of the executive committee of the American Welding Society, which was held July 21st, action was taken on a number of subjects which have important bearing on activities of the society during the coming fall and winter months. The financial condition of the society was thoroughly analyzed, and activities for the immediate future were outlined with a view to increasing the membership, and stimulating other sources of revenue.

Action was also taken on the subject of the co-operation of the society in publication of the second edition of *The Welding Encyclopedia*. After discussion of this subject it was moved that "the American Welding Society endorses *The Welding Encyclopedia*, as it believes that its contents are of benefit to all interested in welding."

It was voted to hold the October meeting of the American Welding Society in Chicago, and if possible to arrange for a joint session with the American Electric Railway Engineering Association. The program so far outlined for the fall meeting, includes papers on the following subjects:

Welded Rail Joints.
Welding in the Electric Railway Shops.
Cast Iron Welding by all Methods.
Resistance Butt Welding.

It was the sense of the meeting that plans should be prepared immediately for a membership drive to be carried on in September and during the October meeting.

NEW ARC-WELD RAIL BONDS

Two new rail bonds, for arc-weld application, have been developed by the Ohio Brass Company, Mansfield, Ohio. They are known as Type AW-7 for base of rail application and Type AW-8 for ball of rail.

The AW-8 bond consists of two copper strands formed into a U and welded into steel terminals which, in turn, are welded to the rail. The AW-7 bond is the same in principle. It has a single strand, of any desired length, welded into suitable steel terminals. Steel to steel is the easiest kind of electric welding; the new bonds conform to this principle. The terminals are slightly rounded and provide a wide angle of scarf in which to build the weld. The steel is heavy and will not be burned through by the arc. A copper sleeve surrounding the strands at the terminal shields the wires and absorbs vibration.

MODERN ENGINEERING COMPANY IN NEW QUARTERS

The Modern Engineering Company, which was formerly located at 23rd and Walnut Sts., St. Louis, Mo., recently moved to a new factory building located at 3411 Pine Blvd.

In addition to a complete line of Oxy-Acetylene and cutting apparatus and supplies, this company is marketing a very attractive looking Cowl Ventilator for automobiles. The ventilator is easily applied to any automobile by simply cutting an oblong hole in the cowl, and this adds considerably to the comfort of the driver.

NEW VISE FOR WELDERS

The Albert Lea Foundry Co., Albert Lea, Minn., have recently perfected and placed on the market a device known as the Globe Welders Vise.

Each section of the vise has five joints, so that the jaws can be swung to any position. It is designed to serve the purpose of an adjustable jig for holding small broken parts in place for welding, and it is claimed to save a great deal of time which otherwise would be lost in blocking up work and turning the work. It also has the advantage of keeping the work in sight, so that it can be lined up properly.

The next regular board meeting of the Compressed Gas Manufacturers' Association will be held on Thursday, Sept. 21st, and will follow a get-together luncheon of the members of the Association at one of the New York hotels. The secretary of the Association says that full particulars will be announced later, and urges that all members who intend going to New York at the end of the summer try to arrange their visits so as to include this meeting.

Give a good welder the right arc welding equipment—and just watch the sparks fly!

G-E Portable Arc Welding Sets ready for shipment to a Western railroad

G-E Arc Welding Sets make the boss and the welder fast friends—because neither can find any reason for hicks

"Good news, Tom! your next outfit's a G-E"

"That's the talk, Mr. Burns! I'll show you some real welding with that set. It's like putting an old pal on the job with me—you know I had one in the other shop, and hung up a record for good, strong welds."

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"Check me as often as you like on its making good—steady arc easy to hold, good penetration, welds overhead slick as new metal—saves you money all the time."

Dick and Harry use G-E arc welding sets same as Tom—and they're glad to speak right up about them too. Bulletins describing G-E welding equipment and the G-E welding school sent on request. Write our nearest office.

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Electric and Magnetic Tests for Welds*

Laboratory Tests Indicate That Electrical and Magnetic Tests May Soon Find Commercial Application

By T. Spooner and I. F. Kinnard†

Introduction.

IN spite of the very rapid progress made in recent years in the application of arc and gas welding, this progress would have been more rapid if at the same time there had been developed a reliable and simple method of determining the quality of welded joints. Provided plenty of reliable and competent operators are available, it is well known that many important structures such as large tanks, steel ships, boilers and perhaps the steel frameworks of bridges and buildings could be safely joined together by welding alone. However, since the results are always in doubt where the human element enters in and since visual inspection alone will not reveal the presence of slag inclusions, incomplete fusion of metal, etc., the application of welding methods have been greatly retarded for important structures where reliability is essential.

There are various possible methods of inspection available such as X-ray analysis, acoustical methods, electrical tests, magnetic tests, etc. This paper will describe some preliminary laboratory tests to determine the possibility of applying electrical and magnetic methods for testing the quality of butt welds joining steel plates. It should be understood that the purpose of these preliminary tests was merely to determine whether or not such methods showed promise of ultimate success and not to develop commercial testing apparatus.

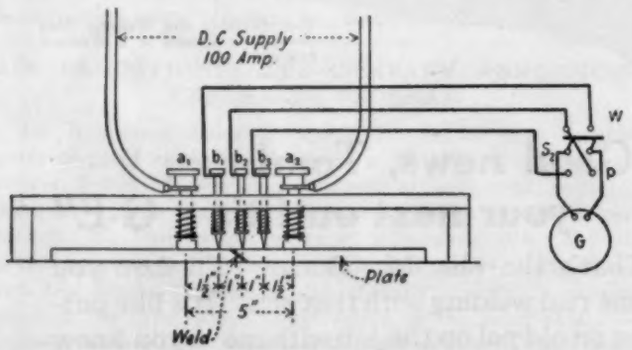


Fig. 1—Electric Testing Apparatus.

Samples

Four pairs of steel plates having the following dimensions were butt-welded by an experienced operator:

Plate	Thickness, in.	Length of Weld, in.
A	½	16
B	¼	24
C	½	24
D	½	24

The joints were made according to a predetermined schedule and were designated by the welder as good, fair and poor, over various sections as will be noted later.

Methods of Test

The method of application was similar for the electrical and magnetic methods of test and consisted in measuring the electrical or magnetic potential drop across the weld with sequently, readings could be readily obtained for any point in the weld which indicated the difference, if any, between the weld and plate at that point. In general the weld had a higher resistance than the plate and consequently the potential drop was greater for the former. The difference between the above readings expressed as a percentage of the plate readings represents the percentage decreases in the quality of the weld based on the plate. The quality of the weld is expressed as 100 minus the percentage decrease as just defined.

The scale was first removed from the plate over the portion to be tested. The plate was then marked off in 1-in. strips and readings were taken at the center of each strip. In all cases these readings were repeated several times and it was found that reasonable checks could be obtained.

Magnetic Tests.—A magnetic tester was designed incorporating the same general principles utilized in the electric method. Fig. 2 shows the general arrangement. A method of measuring magnetic potential drop was original described by Chattock[1] in England and was later used by Rogowski[2] in Germany. A modification of the general principle, due to Fahy[3] and incorporated in his Simplex permeameter was used in our tests. Fig. 2 shows the general arrangement of

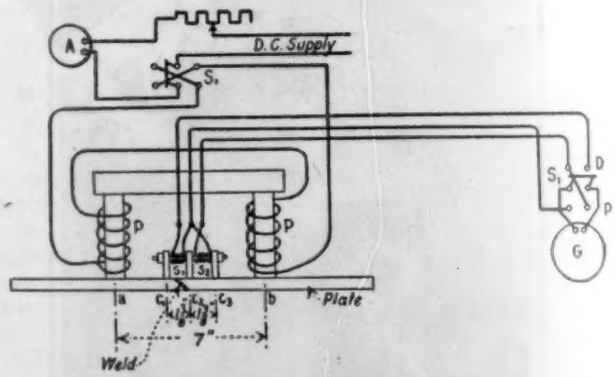


Fig. 2—Magnetic Testing Apparatus.

a definite e.m.f. or magnetic potential applied on opposite sides of the weld. This drop was compared with the drop over an equal length of unwelded plate. The e.m.f. or magnetic potential was applied at point fairly close to the weld in order to realize the effect. If the e.m.f., for instance, had been applied at the edges of the plate parallel to the weld, the current would have distributed itself inversely as the resistivity and the potential drop across the various portions of the weld would have been nearly the same regardless of the quality.

Electrical Tests.—The apparatus constructed to make use of the electric current for weld testing is shown diagrammatically in Fig. 1. The current, in this case 100 amperes D.C., was passed into the plate through to heavy brass posts a_1 and a_2. A galvanometer was connected through the switch S_2 to either b_1-b_2 which was across the weld, or to b_2-b_3 which was across an equal distance on the plate. Con- the apparatus and connections.. In this case the soft iron posts c_1, c_2 and c_3 were used in potential contacts and the drop in magnetic potential across the weld and plate, respec-

*Paper presented before the American Society of Testing Materials, Atlantic City, N. J., June 26, 1922.

†Research Engineers, Westinghouse Electric & Mfg. Co.

tively, was obtained ballistically by means of the air coils s_1 and s_2 which were connected to a ballistic galvanometer. The set-up was arranged so that when switch S_1 was in position D the coils were connected differentially and when in position P the coil across the plate only was connected to the galvanometer. Only sufficient exciting current was used and 15 (1918).

to induce a flux in the plate at about the value of maximum permeability, as it was found for instance that 0.5 ampere worked better than 2 amperes.

After experimenting it was found that for the most consistent results it was necessary to raise the potential contacts from the plate a slight distance with some non-magnetic material. This was done to equalize the effects of scale and non-uniform contacts. Due to the fact that, in some cases, the plates were badly bent and twisted, better results were also obtained by rounding the main contacts at a and b. It is necessary for proper functioning that the potential posts c_1, c_2 and c_3 be symmetrically spaced in respect to each other and to the magnet cores a and b.

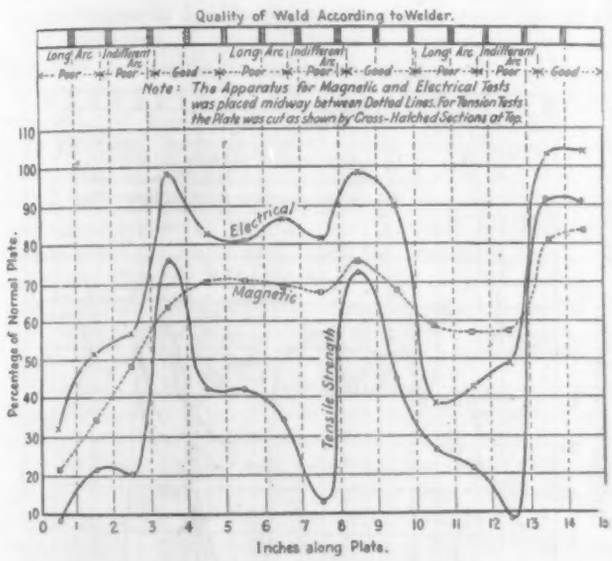

Quality of Weld According to Welder.
Long Arc
Indifferent Arc
Poor
Good
Note: The Apparatus for Magnetic and Electrical Tests was placed midway between Dotted Lines. For Tension Tests the Plate was cut as shown by Cross-Hatched Sections at Top.
Electrical
Magnetic
Tensile Strength
Percentage of Normal Plate.
Inches along Plate.

Fig. 3—Test Results on Plate A.

In the magnetic test, readings were taken along the plate at 1-in. intervals as in the electrical tests. The quality of the weld is expressed as in the electric tests.

Tension Tests.—After completing the electrical and magnetic tests, the plates were cut into 1-in. strips at right angles to the weld and the tensile strength of the strips determined. The cross-section was taken equal to that of the normal plate outside the weld. In most cases rupture occurred within the weld, but in a few instances the strip broke outside, showing that the weld was stronger than the plate. In all cases an average value was obtained for the strength of material in the plate so that the strength of the weld could be expressed as a percentage of that of the plate.

Test Results

The electrical and magnetic tests results for the various plates, together with the quality as reported by the welder, are shown in Figs. 3 and 6. The electrical and magnetic testing apparatus was located midway between each pair of vertical dotted lines as indicated by the test points. For the tensile tests, the plates were supposed to have been cut along the dotted lines. The machining was not accurately done, however, as indicated by the cross-hatched portions at the top of the figures which show the actual cutting positions. The results shown for the electrical and magnetic tests represent data obtained after a good many trials and check runs which were in some cases made on both sides of the plate. A weld equal in quality to the plate is represented as 100 per cent. For points below the 100-per-cent line, the weld is poorer than the plate and above, better.

Discussion of Results

Before considering the results on each plate in detail the following points may be noted. In comparing the electrical and magnetic tests with tensile strength we must make allowance for the fact that the latter tests were made on isolated strips and represent absolute values, while in the former tests adjacent strips have an influence on the value read. Although this does not prevent the electrical or magnetic testing from showing up isolated bad spots, it may

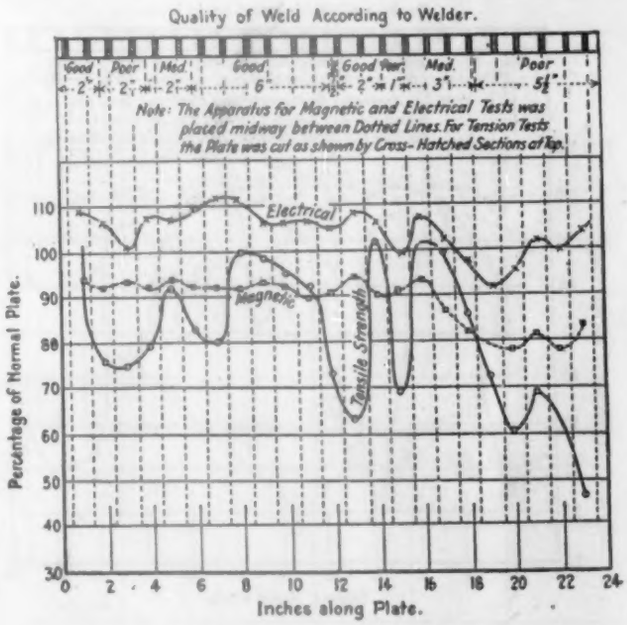


Fig. 4—Test Results on Plate B.

modify them or slightly displace their apparent position since the measurements could not be completely localized. If a good and bad spot are adjacent, the electrical and magnetic tests will give a more or less mean value, whereas the tension tests, which is the absolute test value for one inch, is not of course influenced by the adjacent material since this material has been removed. Moreover, the tension tests tend to be too low as compared with the quality of the completed weld for two reasons:

First, in many cases the two plates welded were no longer in the same plane due to shrinkage caused by unequal cooling and therefore tension tests produced bending strains as well as normal strains; and

Second, if a small slag inclusion or other weak spot was present near the edge of a strip it would tend to spread on pulling, thus reducing the strength of the strips below that to be expected of the completed weld.

It is probable, then, that the tension tests represent a worse condition than actually existed. Moreover, it is quite possible that the electrical and magnetic results more nearly represent the true quality of the weld as a whole, although they probably indicate a weld quality somewhat superior to the actual quality.

[1] *Phil. Mag.*, Vol. 24, p. 94 (1887).
[2] *Archiv, für Elektrotechnic*, Vol. 1, p. 141 (1913).
[3] *Chemical and Metallurgical Engineering*, Vol. XIX, *Sept.* 1

Plate A.—This plate was tested a number of times by both methods. As shown by the curves (Fig. 3) the electrical test follows the tensile strength more closely than the magnetic test does. The latter, though, indicates that the weld is very bad in almost every part. The bad region between the 5 and 8-in. points is somewhat slighted by both tests, although it is not shown as "good" by either one. The good spot between the 2 and 4-in. points is shown by the electrical tests not by the magnetic. It is probable that an isolated good spot will not be picked out by the magnetic test, but the results seem to show that isolated bad spots are readily located, which is presumably more important. It will be well to call attention to the fact that in testing this plate the magnetic tester had been developed to the working efficiency that was reached later. Therefore, there is a possibility that the poor 5 to 8-in. section would have been better detected had it been tested under the later conditions of test. This plate had the poorest welding of the four, which is shown by all the tests.

Plate B.—According to the magnetic tests on this plate

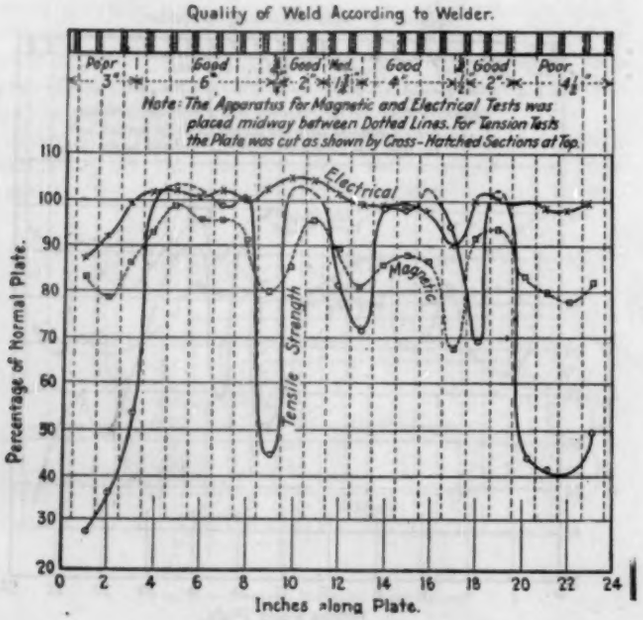


Fig. 5—Test Results on Plate C.

it would be pronounced a good weld with the exception of the end 18 to 24-in. There are evidently some isolated bad spots at some other points, but these are not sufficiently bad to have much effect on the magnetic data. The electrical tests in general shows much the same results as the magnetic. In general we would say that this was the best plate of the four, but that the detail of variations was not brought out very well by either of the two tests.

Plate C.—The magnetic test on plate C seems to follow the tensile strength remarkably well, although the magnitude of the percentages are somewhat different, as would be expected. The strip at 17-in. shows a bad spot magnetically while in the tension test this bad spot seemed to be located at 18-in. However, according to the data on the original welding there was a bad spot located at 17-in. and it is probable that it extended into the 18-in. region. On account of the adjacent good weld at 19-in. the effect of the bad spot was more prominent at 17 than at 18-in. The electrical test on this plate was not so successful and shows a uniformly good plate with the exception of the strip at 17-in. and the section from 1 to 3-in.

Plate D.—Again in this plate the magnitic test follows the shape of the tensile strength curve quite closely. The electrical test also shows quite good results although the latter is displaced above the 100-per-cent line too much. The bad spots in the plate are quite definitely picked out by both tests.

Conclusions

1. It would seem that the foregoing tests will pick out faults in the weld irrespective of what type they may be. For instance it was brought out by an examination of the test strips that a small cross-section at the weld shows up magnetically. On the other hand if there is a surplus of metal at the weld and part of it poor, this condition is detected.

2. From the experimental work here reported it seems that the magnetic methods give the more consistent results.

3. For butt-welding it is quite feasible to definitely state from the magnetic test whether a weld is good, fair or poor when the results are properly interpreted.

4. While the electrical or magnetic tests do not detect small isolated bad spots with certainty, a fairly poor weld extending over considerable distance will be indicated without the slightest possibility of doubt.

5. It is apparent that the tension tests indicate much poorer quality of welds than the magnetic or electrical. However, from considerations mentioned above we believe

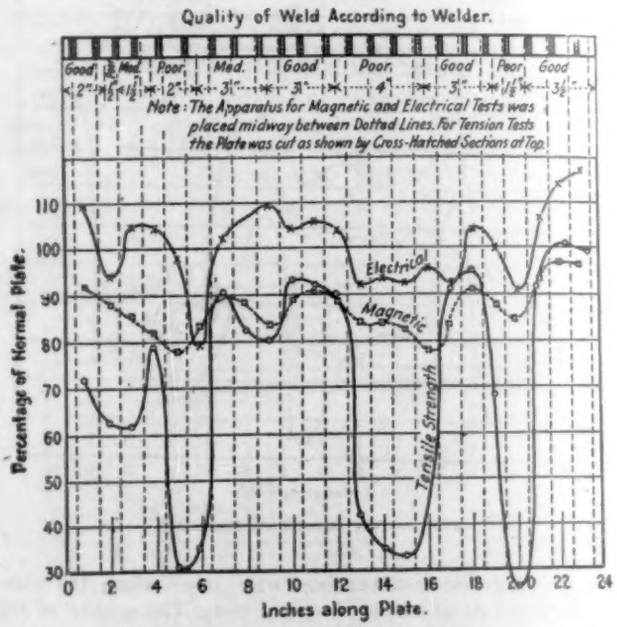


Fig. 6—Test Results on Plate D.

that the tension tests indicate a poorer quality than actually exists while the electrical and magnetic tests show more nearly the average quality.

6. All of the welds with the exception of plate A, Fig. 3, would be considered good average welds. For this plate, the tension, magnetic and electrical tests all agree that this is a poor weld.

7. It should be possible to readily devise a simple and portable apparatus for applying these methods, especially the magnetic, for commercial weld testing. The magnetic method should be more readily applied since actual metallic contact between the testing apparatus and the plate is not essential.

8. These results open up a line of approach to weld testing in general. It remains to be seen whether the foregoing methods can be successfully applied to lap-welded joints and other untried forms. The application to butt-welding alone should be quite important to any industry that utilizes this type of weld extensively.

FLUX COATINGS FOR ELECTRODES

Some Tests Have Been Made to Determine Why the Weld Benefits from the Use of Flux Coating

By J. B. Green *

THE use of Flux-Coated Electrodes is rapidly increasing, but there seems to be very little known concerning their action either among the manufacturers or consumers. Some research has been started in an effort to develop the truth on the subject and this article represents a summary of the preliminary work along this line.

The popular flux-coatings employ practically the same materials as go to make up the slags used in open-hearth steel practice. These are silicon dioxide and calcium oxide. It is a natural supposition that such materials, when present during welding, react to refine the steel the same as in the open-hearth furnace. There are serious objections to such an hypothesis, one in particular is easy to understand. It takes many hours to accomplish the desired refining action in the open-hearth furnace, while the time the slag and metal during welding are in molten contact can usually be measured in seconds. There is no doubt but that most electrodes produce a better weld and require less skill to manipulate when flux coated than when bare. The question is, why is this so?

If a refining action is not the source of benefit, some other must be found. One which seems to give promise has to do with the ease of manipulation of flux-coated rods. A denser, all around better weld can surely be made with a steady arc and smooth flowing rod than with an erratic arc and irregularly, lumpy melting metal. Smooth flow and steady arc are characteristic of most flux-coated electrodes and such working qualities would seem to be a sufficient foundation on which to develop an explanation for the beneficial effects of flux coatings.

A number of tests have now been made. Those proving of interest comprised a series made with rods coated with all percentages of silicon dioxide and calcium oxide, starting with a rod coated with 100 per cent of silicon dioxide, then decreasing this and increasing the calcium oxide an equal percentage until the coating of the last rod of the series represented 100 per cent calcium oxide. It was found that a rod coated with 35 per cent silicon dioxide and 65 per cent calcium oxide produced the best working qualities and best welds. The rods coated with pure materials, either silicon dioxide or calcium oxide gave the next best, although the silicon coated rod had a slight tendency to give a sort of light, snappy, spray sputter which the calcium coated rod did not and, consequently, cannot be rated quite so high. All other percentages say, from about 40 per cent silicon and 60 per cent calcium to 90 per cent silicon and 10 per cent calcium were about the same and proved the least desirable of the series.

After this data was obtained, it was still necessary to connect the results with some properties of the coatings. It seemed more logical that these were physical rather than chemical from what has been said above with reference to the refining action. Further study developed the fact that there is a close connection between the working qualities in this series and the melting points of the various percentage mixtures of silicon dioxide and calcium oxide. From the melting point graph shown in the accompanying illustration, it will be seen that the highest melting mixture produced the best flux coating and the lowest the least favorable. In fact, this melting point graph is really a working quality graph as well for this series of flux coatings.

Still other corroboratory experiments indicate that the beneficial effect of flux coatings is due to the higher melting point of the coating as compared with the material of the rod. Common fire clay seems to make a fairly good coating. The rod has a tendency to melt a little faster and the deposit has a very bright, clean appearance under the scale. This seems characteristic of coatings having a preponderance of silicious materials and appears to be about the only evidence that there might be some chemical reaction.

If all this is true, some generalities can be mentioned regarding desirable characteristics of flux coating. The coatings can apparently be any material whose melting point is sufficiently higher than that of the rod to produce the best effect but not so high that complete fusion does not take place, otherwise solid particles of the coating will become entangled in the weld. Its liquid specific gravity must be considerably less than that of molten

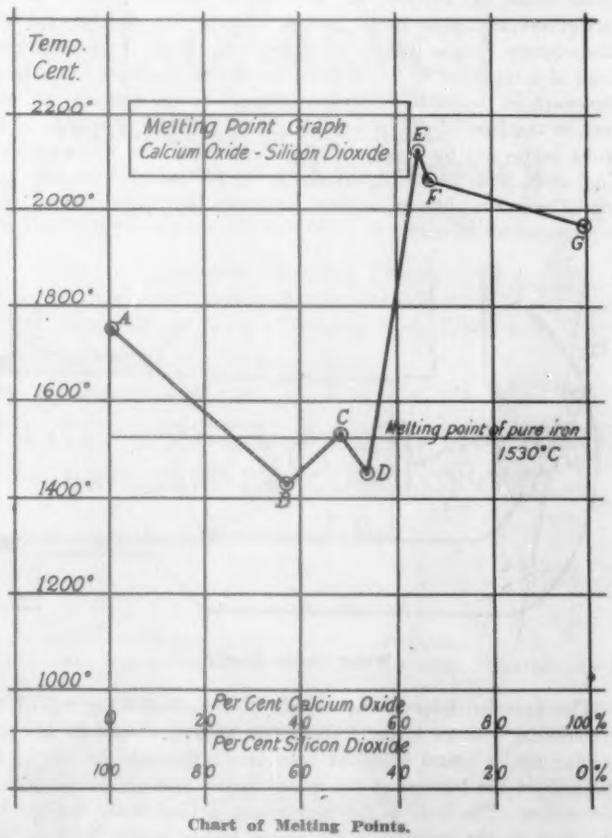


Chart of Melting Points.

iron to insure its floating on top of the weld. It must be immiscible with iron. It must not give off gases which are injurious or disagreeable to the operator. It must be capable of being firmly adhered to the rod and preferably at least in some degree flexible. It must not be so thin that it does not form a complete sheath around the rod at the melting zone. It should have a coefficient of contraction during solidification and subsequent cooling sufficiently less than that of iron to give it a tendency to separate from the weld when cool and be readily removable.

In conclusion it might be said that it still remains to give a scientific reason as to why the differential melting points of coating and rod are responsible for the beneficial effect, if such is actually the case. The author has an hypothesis for this, but further research must be done before it can be published. It will probably be made the subject of a subsequent article.

*With Chicago Steel & Wire Co.

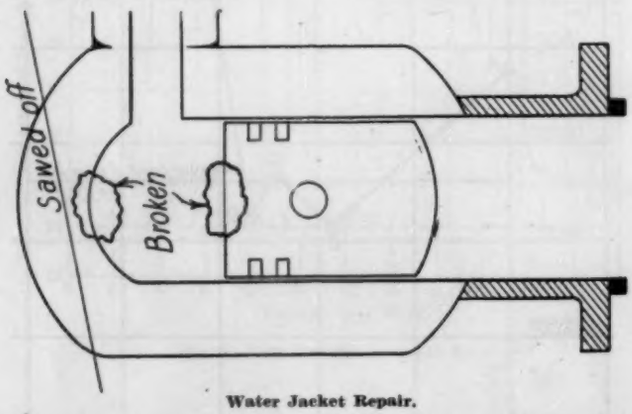
Data for Graph

Point	Per Cent CaO	Per Cent SiO_2	Melting Point	Physical Status	Chemical Status
A	0.0	100	1,750°	Single	$CaSiO_3$
B	37	63	1,436	Compound	SiO_2
C	48.2	51.8	1,540	Single	$3CaO—2SiO_2$
D	54.5	45.5	1,455	Compound	$Ca—SiO_3$
E	65.6	35	2,130	Single	$Ca—SiO_4$
F	67.5	32.5	2,065	Compound	CaO
G	100	0.0	1,975	Single	..... SiO_2
				Compound	..... $CaSiO_3$
				Eutectic	..... Ca_2SiO_4
				Eutectic	..... CaO
				Eutectic	.....

Data largely from Smithsonian Institute Tables.

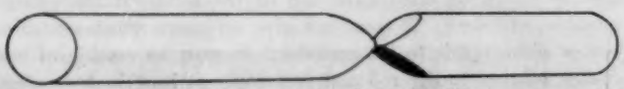
THIS COUNTRY WELDING SHOP GETS MANY VARIED AND DIFFICULT JOBS TO DO

The country town welding shop is a place where welding is quite often the hardest, for it is there that the jobs of all descriptions are encountered and it is most always the case that the country shop is not well equipped. Hickwall is an unassuming sort of a town out in the farming section of Montana. It is lucky, however, in that it has a welder who meets and conquers all comers in the line of difficult welding jobs. Below are some of the jobs performed by Harry Witt, the owner of the Hickwall welding shop, and they will, no doubt, be of interest to others who find themselves, like he, against numerous hard jobs without much equipment to do with.



Water Jacket Repair.

The first in order is the repair of an automobile, one of the commonest visitors to the country job welding shop. In this particular car, a round hole had been blown through the top of the piston and the bottom of the water jacket just above the hole in the piston. The hole in the piston was welded easily enough, but the hole in the cylinder block water jacket was a little harder. It was first necessary to saw out the top of the water jacket so

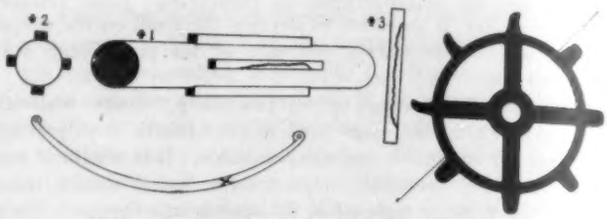


Preparing Rear Axle Shaft for Welding.

that the broken spot could be reached with the torch. The cylinder was then preheated and the bottom hole welded. After the lower hole was repaired, the hole provided as an entry was finished and the job allowed to cool. A few brushes with the emery wheel made the job look so nice that the owner didn't know how it had been done. Later reports to the welder proved that the job was holding well.

In another instance, a broken rear-axle shaft from a 30-50 H. P. tractor was brought in. This was broken in the middle and the process used to weld it, quite clever but simple. It was V'd with a double V because it was 3½ inches thick. The metal was added in the V's, a little at a time, first in one and then in the other until both V's were filled. The welded bar was then placed in a fire and brought to a white heat. After heating, the welds were hammered with a heavy hand hammer until the strength of the joint was completed by the combined processes of welding and forging.

In welding a broken automobile spring, this interesting method was followed: The V was first made as per usual. For a filler



Little Jobs That Keep the Country Welder Busy.

rod, a sliver from an old spring was cut and used instead of the usual filler rods. After the chamfer was filled, the spring was placed in a forge fire and heated until it was soft enough to accept a soaking of borax. After soaking with borax, the welded spring was hammered as was the axle and the job left to cool. Several of these jobs were done and, thus far, have held up in fine shape, according to Mr. Witt.

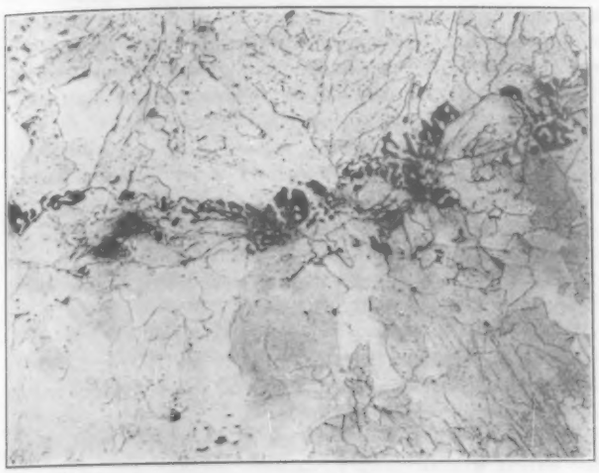
Welding keys that have broken on transmission shafts, is no small job either, and especially is that true if the transmission shaft is of the type used on a large oil-pull farm tractor. This is another job that came to the Hickwall shop. One of the keys had chipped off all along one edge so that it was bevelled instead of square. This was squared up by the torch in such a way that it still gives good service in its place in the tractor now, after some time of hard use. The key had to be well shaped when it was completed for a closely fitted gear slid up and down on its ways over the key.

Aside from the business of actually welding, the welding shop has some other things to do if it is going to be the right sort of a shop. One of these other duties is to advertise and in spite of his being busy doing such jobs as are previously herein described, Mr. Witt has not overlooked this latter obligation. One of his suggestions along this line, and one which he has found to be quite profitable toward the winning of more trade, is to show the "before" and "after" treatment to a welded job. He has a bicycle sprocket hung in his window in a conspicuous place. Part of the teeth in this sprocket are badly worn and the other part is welded, painted and attractively shined up so that the casual passerby will notice the change affected by the welding process and become educated to its advantages.

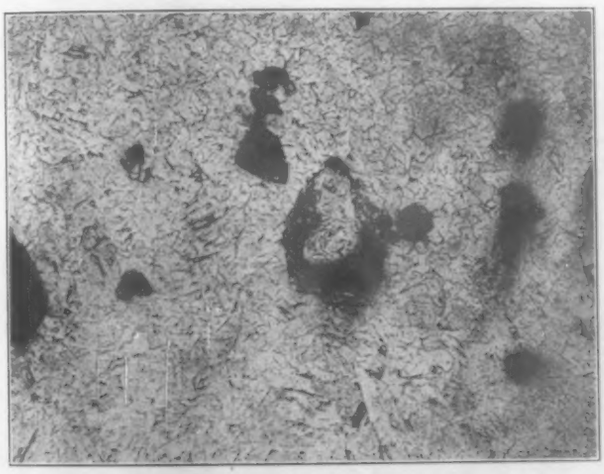
The association of Iron & Steel Electrical Engineers will hold its Sixteenth Annual Exhibit and Convention during the week of September 11th to 15th at Cleveland Public Hall, Cleveland, Ohio. The program does not announce any papers specifically referring to welding but welding equipment will be represented in the exhibits of the General Electric Company, the Westinghouse Electric & Manufacturing Company, Wilson Welder & Metals Company and the Thompson Electric Company.

A welding shop will soon be opened up at 2801 La Salle Street, St. Louis, under the name of the St. Louis Electric Welding Company. The equipment, in this plant, will include electric welding apparatus, muffle and carbonizing furnaces and high speed welding equipment. The manager of the plant is Mr. T. A. Oberchellman.

SLAG in the WELD



Photomicrograph showing Slag in Gas Weld
Made with Ordinary Wire.



Photomicrograph Showing Slag in Electric
Weld, Made with Ordinary Wire.

SLAG in welds is the direct result of slag or slag-forming ingredients in the Welding material.

Slag prevents the grains of the metal from becoming united, which absolutely prohibits the making of a sound weld.

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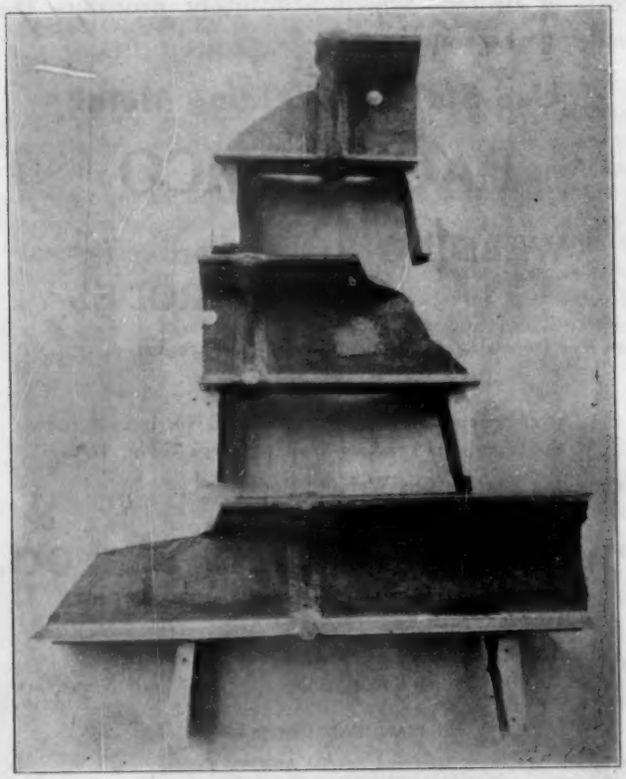
NEW FORM OF THERMIT RAIL WELD

"Center Pour Weld" Reduces Cost of Thermit Insert Rail Weld by Changing Design of Pattern

SAVINGS varying from $2.00 to $3.00 per joint have been made possible by the recent development, by the Metal & Thermit Corporation, New York, of a modified Thermit Insert Rail Weld, wherein the usual reinforcing collar is so proportioned as to give a perfect weld with considerably less Thermit than was formerly believed necessary.

The modified weld, known as the "Center Pour Weld," involves no fundamental changes from the type of thermit insert weld which has been used extensively for 10 years by street railways throughout the United States. By making a great



Tests on "Center Pour" Welds.

many welds and then breaking them, it was found possible to gradually change the design of the pattern so as to utilize the thermit steel collar in the most scientific manner and to best advantage. A slight re-arrangement has also been made in the proportions and locations of the pouring gate, heating gate and riser. A narrower gap is also used between rail ends. It has been found that an average of ⅛ in. gap will give the best results. The saving in using the new weld consists not only in a saving of the Thermit welding portions, but also in the crucibles, as a much smaller crucible can be used, which in turn gives several more reactions per crucible lining. An average of 25 or more reactions per curcible lining can be obtained.

When used in conjunction with new style self luting mold boxes, which require no hand luting whatsoever, the operations merely require clamping the molds to the rails, preheating and pouring. The preheating takes from 20 minutes to one-half hour per joint and the number of joints which can be welded in a day is only limited to the number that can be preheated. When two joints are preheated at a time, there should be no trouble in making 35 to 40 joints per day with a comparatively small gang.

Thermit insert rail welding operations have also been very much simplified by the perfection of a new Thermit mixture which develops such heat that the additions can be mixed cold in it instead of being put in a can and preheated.

Under recent repeated drop tests, sections of rail, welded by this method broke entirely outside of the weld in every instance, thus demonstrating conclusively that the weld was absolutely as strong as the rail. The detailed results of the drop tests are shown by the following data and in the accompanying illustration:

Test No. 1:

Rail section welded—L. S. Co. 134-506.

Nature of Test:

Foundation and support of rail tested—the rail supported on semi elastic foundation, i.e., steel plates were laid on the dirt floor of the welding shop, on the top of which were placed 6 in. Tee rail, and the rail to be tested in turn placed upon this Tee rail on 3 in. centers.

Weight used: 2,500 lbs.

Height of drops: 20 in., 30., 48 in., 79 in.

Results: The last drop was as high as could be given and no deflection or breakage occurred.

Test No. 2:

Rail section welded—same as in Test No. 1.

Nature of Test:

Foundation and support of rail tested—foundation consisted of two 10 in. square steel billets each 3 ft. 8 in. long imbedded horizontally in the dirt floor of the welding shop. On these billets were placed 6 in. Tee rail on 3 ft. center.

Weight used: 2,000 lbs.

Height of drop: One 9 ft. drop only.

Result: Rail tested broke entirely through the rail steel adjacent to the Thermit collar.

Test No. 3:

Rail section welded and nature of test similar to test No. 2 except:

Height of drop—One 30 in. drop only.

Result: Rail broke through the base 3 in. from weld, proving conclusively a rail failure and not a weld failure.

Test No. 4:

Rail section welded and nature of test similar to Test No. 2 except:

Heights of drops: 12 in., 18 in., 24 in., 30 in., 40 in., 50 in., 72 in. 100 in.

Results: No deflection was noted until 40 in drop was made. As nearly as can be measured this deflection for the 3 ft. span was about .005 in. and the deflection after thte 72 in. drop amounted to a total of .014 in. The rail broke at the 100 in. drop, 14 in. from the weld at the base diagonally up through the rail to a point about 7 in. away from the weld on the head, which also proves a rail failure and not a weld failure.

Test No. 5:

Type of rail tested and nature of test similar to Test No. 2 except:

Heights of drops 30 in., 48 in., 66 in.

Results: No deflection took place at the 30 in. drop.

A deflection of .008 in. occurred at the 48 in. drop and the rail broke at the 66 in drop. The fracture occurred 17 in. from the weld at the base and fractured diagonally up through the rail emerging through the head of 4½ in. from the weld, thus showing a rail and not a weld failure.

Note—In none of the Tests Nos. 1-5 inclusive, did the total length of rail after welding exceed 4 ft.

Test No. 6:

Rail section welded—9 in. L. S. Co. 134-470. This section and section L.S. Co. 134-506 (used in previous tests) are almost

identical; the only difference being that the 506 section has a slightly curved contour on the running surface of the head, whereas the 470 section is flat.

Results: No deflection occurred at the 30 in. or 48 in. drop. A deflection of .005 in. occurred at the 66 in. drop and the rail broke at the 104 in. drop. The break occurred through the base 8 in. from the weld and ran diagonally upward toward the weld, breaking through the head alongside of the insert and 1¼ in. away from the weld through the lip. There was a bolt hole through the web of this rail about 2 in. away from the weld and the broken specimen shows a crack extending from this bolt hole toward and through the weld. It is possible that had this crack at the bolt hole been absent, the rail may have broken completely through the head away from the weld.

The modified insert weld was demonstrated on May 12th befor the members of the Committee on Way Matters of the American Electric Railway Association at the Jersey City Plant of the Metal & Thermit Corporation. The simplicity of operation was shown by the fact that one man was able to make a mold, preheat and pour a weld in less than one hour's time.

As nearly half of this was revoted to preheating alone it is evident that a welding gang of say five men con proceed at a much more rapid rate by dividing the whole work so that one man aligns the rails, another makes the moulds, two men clamp molds to rails, operate preheater and pouring welds while the fifth man conveys the molds and other material to the job.

NEW A. E. F. SPOT WELDER

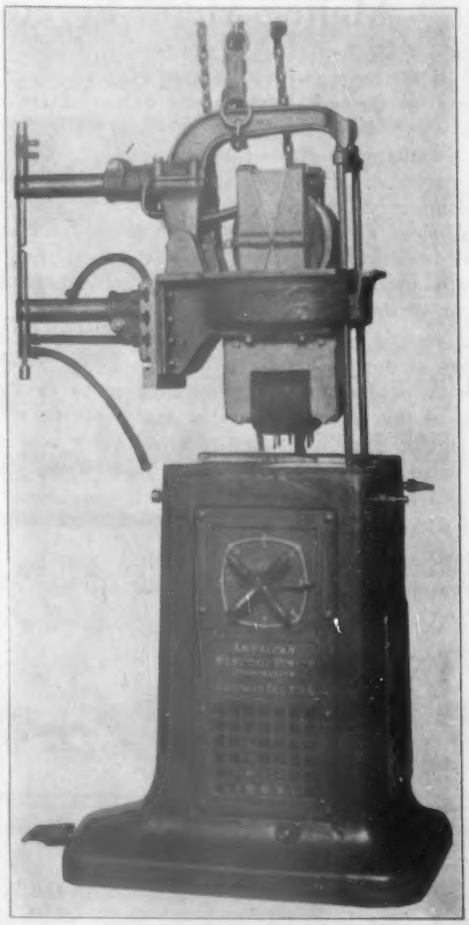
A new type of spot welding machine has been put on the market by the American Electric Fusion Corporation of Chicago. The new product is a smaller machine than previous models which have been made and contains a number of interesting changes in contruction and operation.

One of the important features from the point of view of performance is the new type of automatic switch which

New Model A. E. F. Spot Welder.

closes the current when the electrodes grip the work and opens before the pressure is released. This arrangement takes the current control out of the hands of the operator and it is claimed that it removes one of the serious causes of unsatisfactory spot welds which have been encountered. Spring compression is adjustable permitting control over the heat and pressure during the welding operation. The foot treadle is also adjustable, working on a rod which can be extended and placed to suit the work. Flexibility is provided by a system of heat regulation which allows eight different grades of heat so that the machine can handle sheets from the thinnest gauge up to capacity. The rocking arm is balanced by counter weight instead of a spring, making the operation require the minimum amount of energy.

The lower horn is water cooled and fitted in a substantial socket permitting the use of solid short electrodes. All of the



Showing How Mechanism Can Be Removed From Casing.

cooling water is carried in a neatly arranged galvanized pipe out of the way of the work. The copper electrodes, themselves, are one piece die formed.

A high pressure lubricating system permits the lubrication of all working parts from four easily accessible points. All the moving parts, also all the high voltage electrical parts are completely enclosed. The electrical contact is dependent upon the mechanical grip assuring positive contact all the time. The back door of the machine carries a safety warning switch and provides easy access to the automatic switch and connections. The interior parts are accessible through this panel or through the opposite panel which carries instructions. Whenever it is necessary to inspect the transformer or interior operating parts, they can all be lifted out of the casing as a unit, as shown in the illustration.

At the Eleventh Annual Safety Congress to be held by the National Safety Council at the Cass Technical High School, Detroit, August 28th to September 1st, several of the papers will deal with safety precautions necessary in connection with various welding operations. Safe Practices in Acetylene and Oxygen Welding, by H. S. Smith of the Prest-O-Lite Company, New York City, is on the program for the session of Friday morning, September, 1st.

Headquarters of the Thermalene Gas Corporation have been established at 413 City Bank Building, Kankakee, Ill. The new corporation will manufacture Thermalene Gas Generators and Supplies. S. D. Knight is President, L. Wolf, Vice-President, and J. S. Knight Secretary.

Oxy-Acetylene Used in Metal Coating

Shoop Metal Coating Process First Melts Wire, Then Blows Molten Metal Forcibly Against Surface to Be Covered

ONE of the most interesting new applications of the oxy-acetylene flame is found in the Schoop Metal Spraying Process, which has recently been perfected by the Metals Coating Company of America.

This process consists in the melting and atomizing of any of the commercial metals, either in wire or dust form, and impacting them on any surface. The apparatus employed in this work is adapted for use either in the shop or in the field, and its operation is independent of the size, character, shape or position of the material.

The operating principle of this process is, briefly, that metal wire or dust is first melted by an oxy-acetylene flame, and then the molten metal is blown by compressed air jet in the form of the spray against the surface to be coated.

Three methods of utilizing the process are available, each possessing particular features in its field of application.

1. There is the "Pistol" form which uses metal wire of standard commercial gauges.
2. "Gravitas" which uses metal dust.
3. Then there is the "Mass Coating Machine," the combination of either of the above processes with the large container for holding large lots of small pieces which are to be coated, all at the same time.

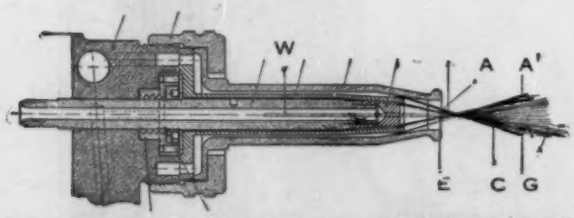


Fig. 1—Application of Reducing Flame to Metal Wire in the Pistol.

A study of the diagram of the mechanism of the pistol barrel as given in Figure 1 will serve to show the usefulness of the intensely hot oxy-acetylene flame in the process.

The pistol, weighing three and one-half pounds, is connected to standard acetylene and oxygen cylinders and to a supply of compressed air, consuming while in use approximately fifteen cubic feet each of the gases per hour and fifty cubic feet per minute at fifty pounds pressure of the air. Metal in the form of standard gauge wire is automatically pulled from a reel into the rear of the gear case in the pistol and fed uniformly and continuously at a rate of from twelve to twenty-four feet per minute to the muzzle of the short barrel, where it enters into a continuous reducing flame zone developed from the gases and air and is there melted and blown at a velocity of about three thousand feet a second (equal to the speed of a rifle bullet) in a very fine spray onto the surface being coated.

The mechanism within the gear case consists of an air-driven turbine operating a wire feeding and straightening device for leading the metal into the barrel. The wire remains cold and unaltered until it emerges from the muzzle, at a point about one thirty-second of an inch from which it is melted and undergoes transformation into spray.

The muzzle is aimed at the surface to be coated and held five to six inches therefrom and in this short distance takes place the change of the wire from a solid to a molten state, thence to the spray and instantly back to the solid practically cold coating. The temperature of the surface being coated is raised but slightly, and it is possible to apply coating to the most delicate objects. As an evidence of the perfect control of the spraying operation, heads of lucifer matches may be coated with molten metal without being ignited, sticks of smokeless powder have been treated and the thinnest paper, fabrics and wood receive the impacting particles of the spray without charring.

The principle involved consists, as shown, in feeding a wire W of any metal into a reducing flame zone Z at such a constant speed that the position of the end of the wire E remains stationary, the melting rate being exactly equal to the rate of feed. The wire end melts and is simultaneously struck a violent blow by an air blast A. In other words, the pistol is a machine gun making its own ammunition from reeled wire and coating any surface by bombarding it with minute plastic particles of metal. Adapted for use in the shop or in the field, on any material regardless of its character, its size, its shape or its position.

The resulting fog or spray of fine metallic particles into which the wire is divided takes the form of a diverging cone C with a core of reducing gas G in which the particles are entrained, and a surrounding sheath of air A which is rapidly expanding and cooling. Any suitably prepared object placed in the path of this metallic spray is coated through impact without elevation of temperature.

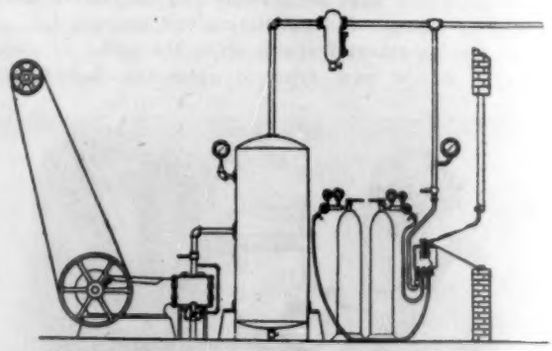


Fig. 2—A Complete Installation for Metal Spraying.

The spray establishes essentially a metal coating airbrush, the diameter of which—5 inc. from the pistol end—is about 2 inc. Objects to be sprayed with metal are operated upon by pointing the pistol normally at the surface to be coated at about 5 in. distance and traversing the pistol across the surface with a regular motion. A single coating is about 0.001 in. thick. The operator's vision easily guides him in distinguishing between the coated and uncoated portions and also between a first and second coat.

Three thousandths of an inch well impacted upon a surface is just as effective as a much greater thickness, and, of course, unnecessarily sprayed metal increases the cost, as the latter is proportional to the thickness. Not only on the score of economy but also to preserve toughness the coating should be of minimum thickness, for the anvil action of the metallic spray on a solid object is lost to some extent as the applications are continued and a process of cold working follows which produces a brittle scale readily detachable. In practice this matter is easily regulated. The pistol can be started in operation at a moment's notice. Expense of maintenance stops as soon as its operation is discontinued.

The success of the pistol in spraying metals from their wire form brought demands for an equipment which had greater speed of operation, such as is required where large

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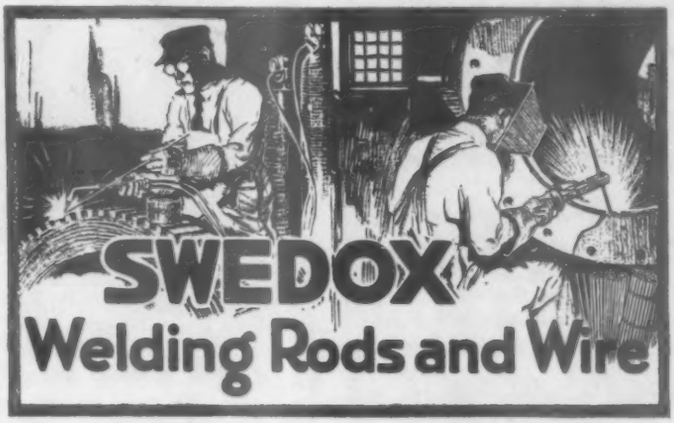

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areas of comparatively flat surfaces were to be coated. These applications called for deposits for protection from atmospheric corrosion or from action of acid, gas, or saline solutions and as the metals best adapted for such work were zinc, lead, aluminum or tin, the "Gravitas" was developed to handle either of these metals in their dust form.

On account of the metals being already atomized, a greater quantity can be heated to a plastic state by the flame in a given time, and added advantages are that less gas and lower air pressure are required to impact them and the possibility of carrying the metallic dust from the container to the muzzle of the torch by air pressure eliminates all moving mechanism from the "Gravitas Gun."

Zinc dust can be purchased at lower prices than zinc wire; lead, tin and aluminum of a proper degree of fineness are also readily obtainable.

This apparatus uses either acetylene, or hydrogen and oxygen in combination with compressed air.

The "Gravitas" consists of a cylindrical container which holds about twenty pounds of the powdered metal. At the top is fitted a removable cover to which is attached a pressure gauge and at the bottom of the container is placed an ingeniously constructed dust distributor. From the distributor the metal dust passes through a rubber tube to the spraying tool or "Gun" which by an ingenious construction passes it between two concentric zones at the muzzle, where it is instantly heated to a plastic state and impacted on the surface to be coated.

The Schoop Pistol operates on an air pressure of fifty pounds, and the Gravitas on fifteen pounds, consuming approximately 50 cubic feet of free air per minute. An 8x8 inch single cylinder compressor or its equivalent furnishes ample capacity for operating one "Pistol" or "Gravitas;" and at the same time, supplies sufficient air for sand blasting. The compressor can be belted up to a line shaft or direct motor driven. An oil separator or equal should be installed in the air line between the supply tank and the spraying device. This eliminates all water, oil and dirt from the mechanism. A reliable air gauge is set in the line immediately above the hose connection which will continually indicate air pressure to the operator. A shut-off valve should terminate the one-half inch pipe, at the point where the rubber hose connection to the tool is made. A complete and practical installation is shown in figure 2.

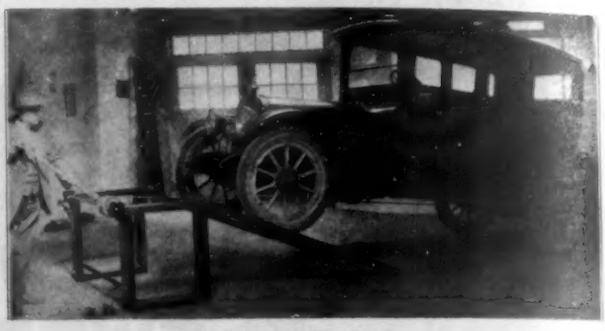
Sand Blast Equipment can be obtained from several reliable makers, the size of the machine depending considerably upon the nature of the work to be handled. An enclosed hood is convenient for small work and a well ventilated room is required where larger articles are to be handled. A reducing valve can be connected to the main air line through which air at about fifty pounds pressure may be used by the sand blast. A good grade of ordinary "railroad" sand is suitable for cleaning metal surfaces, although where reclaiming is possible angular steel grit is preferable.

Commercial oxygen and acetylene gases in standard cylinders are used. One standard oxygen gauge and one acetylene regulating gauge is used for adjusting the proper proportions of each gas to secure the temperature required by the melting points of the different metals. The pistol connections are attached to these gauges with shut-off valves between. A chart accompanying each equipment shows proper gas pressure to be maintained while spraying different metals. he metals used in the pistol are Nos. 13, 19, 20 and 21, B. & S. wire gauge size, these being selected according to their respective melting points.

One of the latest developments in connection with this process, which up to this time has been used only in Europe, is the substitution of the electric arc for oxy-acetylene flame. It has been reported that the use of the arc has made possible the application of the spraying process to a wider range of materials.

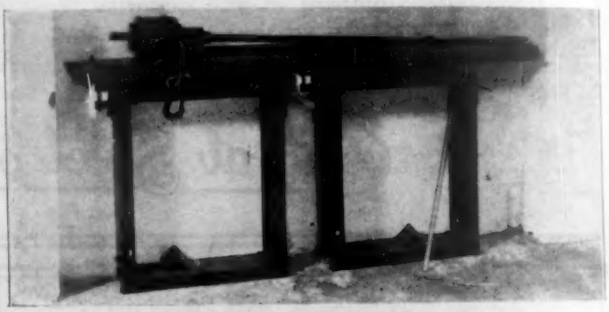
THE KRANER AUTO RAMP AND HOIST

Under patents pending, a very simple, yet thoroughly efficient device is being marketed by J. G. Robel, 155 N. Clark St., Chicago, to relieve the automobile mechanic from the burden of sliding around under the car on his back.



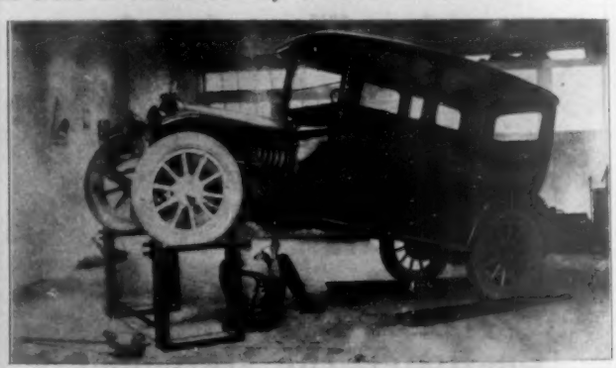
Bringing Auto Up On Ramp.

The Kraner Automobile Ramp and Hoist when not in use occupies a space of eight inches wide and 6 feet, 6 inches long, against the wall of the shop. It may be assembled and a car placed in position as shown in the photograph in about 4 minutes. No bolts or nuts are used to assemble the device. One picture shows its compactness when knocked down. The



Kraner Auto Ramp Folded.

two stands are placed in position and securely locked by means of a steel shaft, the two run-ways or tracks six feet, six inches long and eight inches in the channel are dropped into position, the hand winch is set up on top of the stands, the cable attached to the axle of the car and in a minute and a half the car is elevated to a position where work on either the front or rear ends may be done in comfort. The man



Getting Under The Car.

shown working underneath the car is 6 feet 2 inches tall. In large shops, one winch and one set of tracks only need be purchased, because these parts are all standard and interchangeable.

Although ths device was developed for use in garages, service stations, greasing shops and paint shops, several welders have expressed an opinion that an appliance of this kind could be put to good use in welding shops having automobile work to do. As its total weight is only 500 lbs., it may be readily moved; each unit can easily be handled by one man.

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Non-Flash Apparatus

Unequaled

Records for Success and Size of Installations!

The high standing TORCHWELD enjoys in the iron, steel and metal working industries has been earned—only as such things can be earned—by giving downright good value!

TORCHWELD patented construction provides many advantages, invaluable to the welding and cutting of metals.

Equal Consumption of Oxygen to that of Acetylene for welding.

Equal Gas Pressures for Welding, and lower pressures than usual for cutting.

Freedom from flash-backs—regardless of the size of the welding or cutting job, — gases properly mixed *beyond* heat radius of the work.

Positive safety, whereby any attempted flame propagation into the welding or cutting torch is expelled.

Consider also that TORCHWELD welding torches are machined from solid bar brass stock, and that principal parts of the cutting torches are similarly made; all permanent joints are brazed. Heavy duty welding tips are machined from solid bar copper stock, and are sufficiently heavy to make them sturdy, long wearing, and free from seating troubles. TORCHWELD torches are as well balanced as the beam on a scale; they do not tire the operator.

A comparison of qualities and prices will reveal values you will eventually require and demand in torches, regulators, and general welding and cutting equipment.

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MILD STEEL ELECTRODES for ELECTRIC WELDING

A general purpose wire, guaranteed to conform with the following specifications:

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Also furnished dead soft annealed.

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"RACO" Covered Electrodes are used with either alternating or direct current where bare wires will not give satisfactory results.

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ENGINE DRIVEN WELDING EQUIPMENT DEVELOPED BY WESTINGHOUSE COMPANY

An engine driven welding equipment for use where electric power for motor drive is not available and for job welders who must work in widely scattered districts has been developed by the Westinghouse Electric & Manufacturing Company. This apparatus, which is made in stationary and portable models, also has the advantage of making it unnecessary to waste time applying for a permit or making proper connections before work can be started.

The equipment consists of a Westinghouse single operator welding generator geared to a Doman four-cycle, two-cylinder, low-speed, marine type gasoline engine. The generator is direct current, has a rated capacity of 175 amperes, and a maximum capacity of 225 amperes, at 1,750 rpm. The generator is designed to operate at arc voltage, and to inherently stabilize the arc and supply a substantially constant current of different values over the working range of 90 to 225 amperes. The operating characteristics of the generator are such that it is unusually easy for the operator to strike and maintain the arc, and also to obtain the deep penetration and thorough fusion necessary for satisfactory welding. The shaft of the generator extends through the pedestal bearing and is connected by means of a flexible coupling to the exciter.

The engine is of very rugged construction throughout, the cylinder block and removable head being of semi-steel. The valves, main bearings, and connecting rod bearings are all of liberal dimensions for the service. Other features of the engine are forced feed system of lubrication; Wheeler-Schebler carburetor; Taco throttle governor; impulse starter and large honey-comb type radiator.

The control panel is mounted directly over the generator on a ragid, light-weight angle iron frame work, and the entire equipment is mounted on a substantial cast iron bed plate.

"GEWE" AUTOMATIC OXY-ACETYLENE WELDER

A new type of automatic oxy-acetylene welding machine has recently been placed on the market by the General Welding and Equipment Company, Boston, Mass. The arrangement of the machine is such that the welding rod passes through the center of the torch and is fed downward by gravity. The torch is mounted at one end of a connecting rod that is given motion by a crankpin at the other end. As the connecting rod passes through a pivoted guide, adjustable as to position, it will be seen that the torch will travel in an egg shaped path, the proportions of which can be changed, according to the position of the pivoted guide. In addition, the whole machine may be given motion at a right-angle to the mean of the motion imparted to the connecting rod. A combination of these two motions will cause the torch to travel in the path of an approximate cycloid. As the motion of the whole machine can be given more or less amplitude, the torch may be made to travel through a variety of paths.

The combination motion is used in welding a seam. For heavy welds an additional torch is supplied which precedes the welding torch and preheats the metal.

The machine has two speed adjustments, one by means of a friction wheel and disk and the other through a rheostat controlling the motor. By means of the rheostat, not only can finer speed adjustments be made but variations of speed can be made at points where the thickness of the metal varies.

RAILWAY MEN HEAR WELDING STORY

A recent issue of the *Railway Age* states that an unofficial, but highly successful, meeting of railroad and supply men interested in welding was held at the time of the Annual Railway Convention. A group of the most enthusiastic boosters of the American Welding Society got together with about fifty of the railroad men who are interested in the subject, and explained the objects of the society to them.

C. A. McCune, President of the American Welding Society, pointed out that the society is a national body whose object is to promote welding—that is, to promote it by standard methods, standard specifications for material and generally the laying out of standard methods of handling the process, which will be of assistance to the entire welding industry. Its further object is to set forth all the valuable and authentic information that it can possibly gather as a result of co-operative research.

W. E. Symons supplemented these remarks by pointing out how many of the exhibitors and guests at the convention were vitally interested in welding, and how much benefit they could all derive through membership in the American Welding Society.

J. H. Deppeler followed with an interesting talk in which he pointed out how beneficial it was for the individual members of such an organization to boost every one of the various welding processes instead of finding fault with competitive processes.

Mr. C. J. Holslad enlarged on Mr. Deppeler's remarks by saying that after the members of the American Welding Society got acquainted they all discovered that their competitors were normal human beings.

Mr. W. A. Slack enlarged on the explanation of the activities of the American Welding Society by describing the journal which it publishes monthly, telling of the information which it carries to individual members.

Mr. C. M. Rogers spoke from the point of view of the user of welding equipment, describing the benefits of the process from the point of view of both production and repair work.

A particularly strong speech in behalf of the society was made by H. D. Bentley of Chicago & Northwestern Railroad. "I don't know what the railroads of this country would have done during the times when we were hardly able to get material of any kind if it had not been for the welding apparatus and appliances brought into use in the last few years," said Mr. Bentley. "Mr. Symons says there isn't any question but that there is a great need of an organization with just as much concern in the interests of autogenous welding as the Master Mechanics' Association has had for mechanical details and I am very glad to know that there is a national society that now has branches in a good many of the cities which are apparently doing very good work. I sincerely hope that any of you men who have the opportunity of lending your influence to join such an organization will do so, because I am certain it is going to be of benefit to your railroads and to yourselves. I have attended a few meetings at Chicago and I want to tell you that those I have attended have been full of interest. Of course, we go through the shops as officers and we see these things done, but when you go to meetings and find out from the men who are doing the things how they should be done so that failure can be overcome, it is an inspiration.

"It is a money making proposition for you and your companies to further the interests of the American Welding Society by joining it, or by becoming members of the local sections that may be started in your town. The welding art has a future before it. It is in its infancy now, and some day five or six years hence we will be astounded to know what is being done and what can be done by the autogenous welding processes. I presume that certain jobs can be done better electrically and that for others the gas method of welding is superior. Each system has its uses and it is up to us to learn which will do the work the most economically and safely."

Edward Wray, publisher of *Railway Purchases and Stores*, speaking from the point of view of the observer in the stores department, pointed out that the use of welding on railroads for reclamation work is constantly on the increase.

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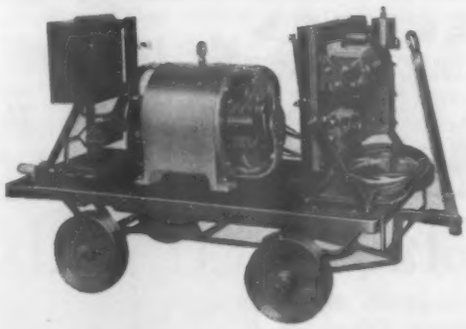

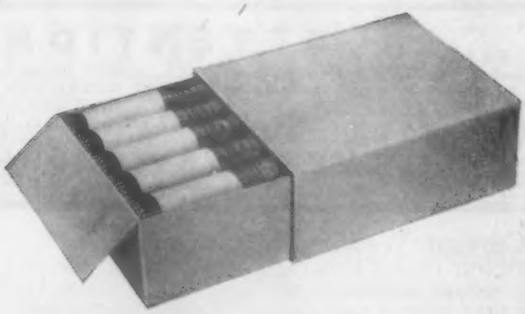

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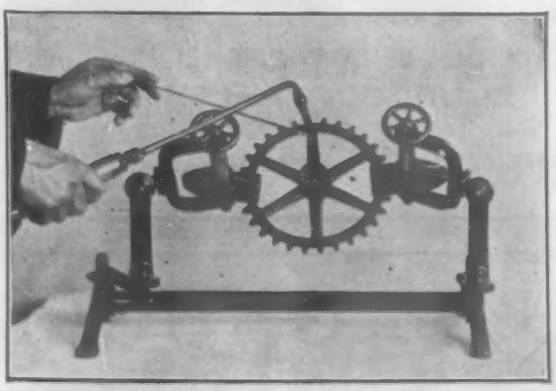

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Current Welding Literature

WELDING TRACK FROGS FOR FROFIT, by C. J. Mackie—It is profitable to reclaim rigid track frogs for further service by building up the worn surfaces with a torch. Welding shops should be conveniently located and records of costs and savings should be kept carefully. Frogs must be welded before the wing rails are cut to pieces and points of the frogs broken down.—Railway Purchases and Stores, August.

USE AND ABUSE OF ELECTRIC ARC WELDING IN LOCOMOTIVE WORK, by C. W. Roberts—Failures which occur in Electric Arc welding are largely due to the inefficiency and indifference on the part of the workmen. A series of examples of failed welds are shown by illustrations to have been caused almost entirely by improper application of the process. Usually the trouble is faulty preparation of the work. It cannot be expected that the welds will have the same strength as the original piece, but by observing the rules the welder can always make a joint which will hold.—Journal of the American Welding Society, July.

A MANAGERIAL STUDY OF OXY-ACETYLENE CUTTING AND WELDING IN FOUNDRIES—Installation of Oxy-Acetylene equipment demands the careful attention of superintendents and managers to the establishment of correct methods in application of the welding and cutting process.—Acetylene Journal, August.

RELATIONSHIP BETWEEN PHYSICAL PROPERTIES OF FILLER ROD AND WELD, by J. B. Green—A discussion of the composition of the welding rod and its effect on the weld.—Acetylene Journal, August.

WELDING DURALUMIN, by Horace C. Knerr—An account of the experimental work done at the Naval Air Craft Factory, and of results obtained from this work and from welds made by private firms. Details of tensile and corrosion tests made on different types of welds indicate that the difficulties encountered in duralumin have not all been overcome. The flange method is considered preferable. Heat treatment prevents corrosion and increases strength.—Acetylene Journal, August.

BEST METHOD OF WELDING SAFE ENDS ON TUBES—Committee report before the Master Boiler Makers Association reflects the somewhat divided opinion on the subject of scarfing safe ends, but recommends that the sharp burr be taken off the outer edge of the safe end before inserting it into the tube. When the flux is used it is recommended that it be kept perfectly clean.—Railway Journal, July.

CAST IRON, by Capt. B. Turner—Booklet published by Ferro-Arc Welding Co., London. Describes the characteristics of cast iron, the difficulties involved in arc welding of cast iron. Tells causes of cracks and strains, and how the latter may be relieved. The characteristics of Malleable Cast Iron and the methods of arc welding are given together with some hints on welding with cast iron electroes.

ROEBLING WELDING WIRE—New booklet recently issued by John A. Roebling's Sons Co. Gives the chemical analysis of the various Roebling wires with description of the packing and marking used on each grade. Also includes data on current values for different thickness of metal.

CUTTING STEEL CAR AND LOCOMOTIVE BOILER RIVETS, by E. A. Murray—Description of the motor generator set and carbon arc cutting tool used by the Chesapeake and Ohio shops for burning off riveted heads on steel cars. Method of connecting the power supply to the work is described in detail. Records indicate a saving of 50% as compared to the use of rivet busters. Work is now being done in the locomotive department—Railway Mechanical Engineer, July.

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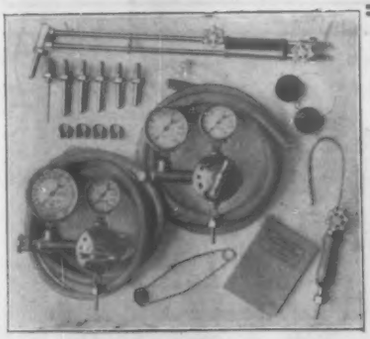

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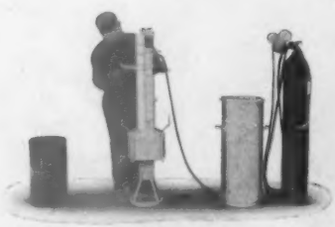

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